Charm Industrial Great Plains Bio-Oil Sequestration Project Design Document

v1.5 – 5/30/2024

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Section A – Key Project Data

Title
Please provide the title of your Project. This will be displayed as your Project's name on the Isometric Registry and all related documentation.
Charm Industrial Great Plains Bio-Oil Sequestration

Description
Please provide a brief description (50-100 words) of your carbon removal Project. A more detailed written technical description must be provided later.
Charm is procuring pyrolysis bio-oil produced by AE Cote-Nord Canada Bioenergy Inc (AECN) from waste material produced by a nearby lumber mill. We are using a combination of rail and truck to transport the bio-oil to our pre-processing site in Kansas where it is treated to fit the local regulatory requirements for injection before being trucked to the cavern where it will be injected for sequestration and monitored.

Project Location(s)
• *Please submit at least one Address and/or specific geo-coordinates for the project.* • *You may submit multiple Project locations – please specify what role each location plays in the Project.*
Location of Pyrolysis: Produits Forestiers Arbec S.E.N.C., 175 Bd du Portage des Mousses, Port-Cartier, QC G0W 1X0, Canada 50.025323, -66.818910 Location of Bio Oil Pre-Processing: 838 SW Purity Springs Rd El Dorado, KS 67042 37.813906, -96.914982 Location of Injection: Underground Cavern Stabilization, 7513 KS-14, Hutchinson, KS 67501 37.966035, -97.947845

Project Participants
Please provide a complete list of organizations participating in the project, with a contact person for each organization. (*Please duplicate the below rows for each additional organization you wish to add)*
Company registration number (*Unique business identification number in your country of*

registration): 82-4423905
Organization Name: Charm Industrial
Organization Address: 2575 Marin Street San Francisco, CA 94124
Contact Person: Max Lavine
Contact Email Address: max@charmindustrial.com
Contact Phone Number: 800-778-7879
Organization role in Project: The carbon removal company who will fund and manage the offtake, transportation and treatment of the bio-oil and sell the CDR credits.

Company registration number (*Unique business identification number in your country of registration*): 92-2524153
Organization Name: Carbon Removal Co., Inc. dba Vaulted Deep (Vaulted)
Organization Address: 11000 Richmond Avenue, Suite 191, Houston, TX 77042
Contact Person: Julia Reichelstein
Contact Email Address: info@vaulteddeep.com
Contact Phone Number:
Organization role in Project: Injection well operator

Company registration number (*Unique business identification number in your country of registration*): 1168427111
Organization Name: AE Cote-Nord Canada Bioenergy Inc.
Organization Address: 210-8000 Boulevard Langelier Sant-Leonard, QC H1P3K2 Canada
Contact Person:
Contact Email Address: pct.rh@arbec.co
Contact Phone Number: 418-766-2299
Organization role in Project: Bio-Oil Vendor

Legal ownership of carbon removal claims

Please provide reasoning and evidence for legal ownership over the rights to all removals that will be claimed from the Project and refer to Section 3.1 "Ownership" of the Isometric Standard.
Charm Industrial is the only organization that will have ownership of the carbon removal claims resulting from this project. Our relationship with all other organizations involved in the project is limited to contracting for specific goods and/or services required to complete the project. Confirmation that the provider of the bio oil is unable to claim carbon credits for its production once sold to Charm is included in the documentation for this PDD.

Technical description of Project activity
Please provide a brief technical description of your carbon removal Project activity in accessible language. This should include information on facilities and equipment, the age and average lifespan of equipment, and all further information essential to understanding how carbon removal is achieved by the Project.
Charm offtakes finished bio-oil from AE Cote-Nord Canada Bioenergy Inc. (AECN), a Quebec manufacturer who operates a pyrolysis facility. Construction began in 2016 and the facility was commissioned in 2018. It is expected to operate through 2042 and produce approximately 871,200 metric tonnes of pyrolysis oil during that time. AECN's pyrolysis plant is located next to the Arbec lumber mill, which provides the pyrolysis feedstock in the form of waste sawdust and shavings from lumber processing. The production of this waste is incidental to the production of wood boards for construction, which is the mill's primary source of revenue. Absent an offtaker, the historical fate of the mill residue has been on-site piling, as is evidenced by the fact that the mill has already accumulated a large pile of sawdust that is years old. Piled, rotting wood waste is a source of both CO2 and methane emissions, with a significant global warming potential. By sequestering AECN bio oil, Charm enables AECN to divert more of this ongoing waste stream away from creating emissions, instead permanently sequestering the biogenic gasses underground and interrupting the emissions associated with the input biomass. Charm contracts with transport providers to deliver purchased bio-oil is transported to Charm's pre-processing facility in El Dorado, KS. At this facility, the oil is introduced to our material tanks and treatment system, which was constructed/commissioned in 2023-4 and has an expected useful life of 10 years of bio oil processing. This site allows Charm to treat the bio-oil prior to injection in order to ensure that it is fully compliant with the requirements for underground injection specified by the KDHE and Vaulted's Class V injection permit. Once successfully pre-treated to ensure UIC/KDHE compliance, the oil is trucked to Vaulted's Great Plains Facility in Hutchinson, KS for injection into an underground salt cavern. Following treatment, samples are taken for CHN, TAN, and Density testing and the oil is transported to the Vaulted injection facility. At that point, the oil is offloaded and Vaulted takes custody of the product and responsibility for emplacing it into the storage cavern. Vaulted is also contracted to monitor the emplacement cavern and provide Charm

with MRV data from their monitoring equipment. The details of Vaulted's injection infrastructure and monitoring equipment is detailed in their own PDD and recorded in the relevant sections below.

Declaration of exclusive registration	
Please confirm that your Project may only claim credits for activities that are exclusively registered with the Isometric Registry.	
X	I confirm the Project for which I aim to generate credits under the Isometric Standard is not registered with any other voluntary or compliance scheme.

Public funding
Please describe briefly whether your Project has received any public funding, e.g., grants or subsidies
This project has received no public funding

Estimated carbon removal capacity
Please give an estimate of the net carbon removal capacity of this project in the coming years (metric tonnes) The carbon removal capacity of the project is estimated based on a number of factors. The gross carbon sequestered via conversion of the waste biomass to bio-oil is calculated based on repeated carbon testing of the oil in order to establish confidence in a consistent baseline. The emissions generated via production, transportation and injection are measured, calculated or estimated depending on the type of parameter and the variability or opportunities for improvement (e.g. transitioning transportation from fossil fuels to renewable energy sources). The net carbon sequestered is then estimated and forecasted into future years based on known and estimated capacity and operating constraints (e.g. pyrolysis capacity, injection capacity). Additionally, because the Project is defined by the injection site, rather than the feedstock or bio-oil source, these figures are based on the assumption that Charm will be injecting bio-oil produced by multiple providers, including Charm's own pyrolysis operations, as well as additional third-party producers. Additional information regarding these sources will be added to this PDD in the future. Given the above, the following estimates represent Charm's overall forecast for injections at this site as our operations and supply chains expand. As a startup operating in an emerging market, there are necessarily many sources of uncertainty in these estimates, as operating parameters, feedstocks, transport methods, etc. will be both diverse and subject to change as operations expand and market conditions evolve. In order to ensure conservative

forecasting, the totals for 2026-2028 are marked as TBD and will be updated in the future as third-party offtake volumes and Charm's own production levels are more defined.

Year	**Estimated carbon removal capacity (metric tonnes)**
2023	N/A
2024	10,000
2025	25,000
2026	TBD – 25,000 +
2027	TBD – 25,000 +
2028	TBD – 25,000 +

Section B – Protocol and Monitoring Data

Selected Certified Protocol	
Please select the Isometric Certified Protocol you wish to use for this Project. *Please note that, as per the Isometric Standard, you must use the latest available version of a Certified Protocol, unless a grace period has been explicitly specified by Isometric, whereby a former version of a Protocol may continue to be used for a defined time period.*	
Protocol Name: Bio Oil Geological Storage	
Protocol Version Number: v1.0	
X	I confirm that I am using the most recent available Certified Protocol version, or that a grace period has been explicitly specified allowing the use of an earlier protocol version.

Project Eligibility
Please explain why this Project is eligible under the selected Protocol.
1. Biomass feedstocks are eligible in accordance with the Biomass Feedstock Accounting module. Please see the Biomass Feedstock Information appendix for full details on each feedstock and demonstration of eligibility. 2. The project is injecting bio-oil produced from eligible feedstocks into a US salt cavern for long-term storage using a permitted underground injection well as contracted with Vaulted, the well operator, who has also had the site approved under Isometric's Biomass Geological Storage Protocol for their own unrelated sequestration activities.

3. The project is additional – See the below sections demonstrating Additionality for further details.

Acknowledgement of responsibility for providing notification of changes to operations	
Please confirm that you acknowledge responsibility for notifying Isometric of changes to operations which deviate from this submitted PDD	
X	I acknowledge responsibility for notifying Isometric of any changes to operations

Project Boundary
Complete the below table detailing the Project boundary, including all GHGs considered across all Sources, Sinks and Reservoirs (SSRs) in both the Project and Baseline scenario. *Additionally, please give a description of the Project boundary. You may also optionally provide a diagram of the Project boundary.*
Description of Project boundary: All project activities undertaken to permanently sequester carbon are considered within the system boundary including: transportation of biomass feedstock to pyrolysis, the process of pyrolysis itself, transportation of injectate to and from pre-processing, the pre-processing itself, injection and monitoring activities. Embodied emissions associated with equipment procured or contracted by Charm for the purposes of project execution are included. The emissions resulting from the direct and induced use of energy (fuel, electricity) and the embodied emissions of non-waste consumables are included. Any counterfactual use case of organic waste biomass, including any relevant replacement emissions, are also included – However, because the biomass has no counterfactual use, the replacement emissions are 0. See Appendix 1 for details. Because the biomass feedstock is a waste product (sawdust) produced by a lumber mill whose function and production of waste is not contingent on this project, the upstream emissions associated with growing, harvesting, transporting and producing the biomass are not included within the boundary. Geographic Boundary: Pyrolysis occurs in Port Cartier, QC. Injectate is transported from the Pyrolysis location by a combination of truck and rail to the pre-processing facility in El Dorado, KS. Once pre-processing is complete, injectate is trucked to Vaulted injection site in Hutchinson, KS for emplacement.
[Optional] Project boundary diagram:

Baseline / Project	**Carbon Flux / Emission Source**	**Included/ excluded from project boundary?**	**Greenhouse Gas(es)**	**Justification/description**
Baseline	Counterfactual Emissions: Fuel Use from Feedstock Sourcing and Creation	Excluded	CO_2, CH_4, NO_2	There is no additional fuel usage on the part of the feedstock supplier due to project activities. The feedstock is a byproduct of commercial activities that would have been carried out absent the project, and are therefore considered as zero for the purposes of this document. Full details can be found in Appendix 1.
Baseline	Counterfactual Emissions: Electricity Use from Feedstock Sourcing and Creation	Excluded	CO_2, CH_4, NO_2	There is no additional electricity usage on the part of the feedstock supplier due to project activities. The feedstock is a byproduct of commercial activities that would have been carried out absent the project, and are therefore considered as zero for the purposes of this document. Full details can be found in Appendix 1.
Baseline	Counterfactual Emissions: Replacement of Feedstock Function	Excluded	CO_2, CH_4, NO_2	Feedstock is a waste product from commercial activities that would have been carried out absent the project. The supplier developed pyrolysis capacity as a solution to excessive residue accumulation. Therefore replacement emissions are considered 0 based on Biomass Feedstock Sourcing criterion C1: The feedstock currently serves no purpose. Full details can be found in Appendix 1.
Baseline	Counterfactual Emissions: Temporary Carbon Storage from Feedstock	Included	CO_2, CH_4	The Arbec sawmill accumulated a large pile of sawdust and wood shavings as a result of the shutdown of local businesses who had purchased these residues in the past. AECN was developed as a solution to this issue of waste

				accumulation. Research on sawdust piles (Pier and Kelly, 1997) has shown that due to anaerobic conditions within the pile, the total global warming potential of pile emissions within 15 years would be greater than the emissions from a total release of biogenic carbon due to the production of methane. Charm is only calculating removal credits in terms of the release of biogenic carbon. Full details can be found in Appendix 1.
Project	Feedstock Sustainable Sourcing	Included	N/A	Feedstock for the project is harvested by Groupe Remabec from provincially-owned forests under rights granted by the Province of Quebec as part of the Provincial Management Plan for forests. In addition, Groupe Remabec's harvest activities have been granted SFI certification by the Bureau de Normalisation du Québec.
Project	Fuel Use from Feedstock Transport	Included	CO_2, CH_4, NO_2	Fuel use from feedstock transport is provided as part of bio oil vendor LCA and included in their calculation of CO2e/ton of bio oil produced
Project	Embodied Emissions from Feedstock Transport	Included	CO_2, CH_4, NO_2	Per-mile embodied emissions are calculated based on GREET emissions levels for the manufacture of medium-and-heavy-duty trucks and trailers and divided by EPA expected useful life in mileage for heavy-duty diesel engines. This calculation yields a per-mile embodied emissions level that can be applied to Charm-specific journeys using vehicles owned by the vendor
Project	Fuel Use from Biomass Pyrolysis	Included	CO_2, CH_4, NO_2	Fuel use from feedstock pyrolysis is provided as part of bio oil

				vendor LCA and included in their calculation of CO2e/tonne of bio oil produced
Project	Electricity Use from Biomass Pyrolysis	Included	CO_2, CH_4, NO_2	Electricity use from feedstock pyrolysis is provided as part of bio oil vendor LCA and included in their calculation of CO2e/ton of bio oil produced
Project	Stack Emissions from Biomass Pyrolysis	Included	CH_4, NO_2	AECN has not directly analyzed the emissions from their process. Pyrolysis stack emissions are routed to heat the biomass dryer, which is the sole source external system exhaust. In lieu of a direct analysis, Charm is using an analysis of the same technology pyrolyzing woody biomass as reported by their LCA software provider (GHGenius) to the Canadian Government to quantify emissions CO2e. AECN will conduct emissions testing by the end of 2024 and once that information is available, directly measured values will be used as discussed in the Monitoring Plan.
Project	Embodied Emissions from Facilities and for Equipment Biomass Pyrolysis	Included	CO_2, CH_4, NO_2	The bio oil vendor has not performed an evaluation of the embodied emissions associated with the construction of their building or manufacture of their equipment. Therefore, the best option available to Charm for determining these impacts is to use a cost-based calculation based on costs incurred by AECN. This is achieved by applying per-dollar-spent supply chain emissions factors to the cost of construction and equipment and dividing that total by the expected lifetime production of the facility to arrive at a quantity of CO2e per MT of oil produced associated with facility embodied emissions.
Project	Fuel Use from	Included	CO_2, CH_4,	Emissions impact of transport

	Injectate Transport to Pre-Processing		NO_2	calculated based on GLEC emission factors using cargo weight, vehicle type, and distance traveled with a correction for truck scale uncertainty detailed in the Uncertainty Analysis
Project	Embodied Emissions from Injectate Transport to Pre-Processing	Included	CO_2, CH_4, NO_2	Per-mile embodied emissions are calculated based on GREET emissions data for the manufacture of medium-and-heavy-duty trucks and trailers and divided by EPA expected useful life in mileage for heavy-duty diesel engines. This calculation yields a per-mile embodied emissions level that can be applied to Charm-specific journeys using vehicles owned by a transport contractor. Because GREET does not provide comparable emission factors for the manufacturer of railcars, a cost-based calculation is used based on the average cost and expected useful life of a DOT-111 railcar
Project	Electricity Use from Injectate Pre-Processing	Included	CO_2, CH_4, NO_2	Electricity emissions are calculated by kWh usage multiplied by the per kWh emissions for the SPP North grid subregion as reported by the EPA eGrid emissions factors. This is supplemented by a per-kWh addition to account for the embodied emissions associated with grid infrastructure as quantified by a weighted average of power generation sources based on the fuel mix for the subregion reported by the EPA and the applicable electricity infrastructure emissions factors reported by GREET
Project	Fuel Use from Injectate Pre-Processing	Included	CO_2, CH_4, NO_2	Emissions impact of fuel usage is calculated based on GLEC emission factors for fuel combustion in terms of TCO2e/kg fuel multiplied by the quantity of fuel purchased for use on site as

				documented by purchase invoices. This quantity is corrected for fuel pump uncertainty as detailed in the Uncertainty Analysis
Project	Embodied Emissions from Facilities and Equipment for Injectate Pre-Processing	Included	CO_2, CH_4, NO_2	Material weights for on-site equipment owned by Charm are estimated by the site manager based on a site equipment list and expert judgment. Weights are multiplied by the appropriate GREET emissions factor for the corresponding material and the CO2e calculated is divided by the expected useful life of the equipment in order to compute a straight-line amortization rate deducted from removals associated with the site during each reporting period over the equipment's useful life. The embodied emissions associated with rented equipment are computed using a cost-based calculation in which a per-dollar-spent supply chain emissions factor is applied to the average market value for the equipment. This value is divided by the expected useful life of the equipment (measured in hours) and multiplied by the average number of hours of weekly service as estimated by the site manager. This value is deducted from removals associated with the site during each reporting period in which the equipment is in service.
Project	Embodied Emissions from Consumables for Injectate Pre-Processing	Included	CO_2, CH_4, NO_2	Liquid caustic soda (LCS) is added to the bio oil at a volume measured by on-site staff using a flow-meter. The rate of LCS addition is measured for each injection batch and multiplied by the GREET emissions factor for LCS to calculate the associated embodied emissions. The salt added to the oil

				is not included because it is an incidental waste-product (off-spec/non-saleable salt) from a salt production facility
Project	Fuel Use from Consumables Transport to Pre-Processing Site	Included	CO_2, CH_4, NO_2	Emissions impact of transport calculated based on GLEC models using cargo weight associated with material delivered to the site, vehicle type, and distance traveled with a correction for truck scale uncertainty detailed in the Uncertainty Analysis
Project	Embodied Emissions from Consumables Transport to Pre-Processing Site	Included	CO_2, CH_4, NO_2	Per-mile embodied emissions are calculated based on GREET emissions data for the manufacture of medium-and-heavy-duty trucks and trailers and divided by EPA expected useful life in mileage for heavy-duty diesel engines. This calculation yields a per-mile embodied emissions level that can be applied to Charm-specific journeys using vehicles owned by a transport contractor.
Project	Fuel Use from Processed Injectate Transport to Injection Site	Included	CO_2, CH_4, NO_2	Emissions impact of transport calculated based on GLEC models using cargo weight, vehicle type, and distance traveled with a correction for truck scale uncertainty detailed in the Uncertainty Analysis.
Project	Embodied Emissions from Injectate Transport to Pre-Processing	Included	CO_2, CH_4, NO_2	Per-mile embodied emissions are calculated based on GREET emissions data for the manufacture of medium-and-heavy-duty trucks and trailers and divided by EPA expected useful life in mileage for heavy-duty diesel engines. This calculation yields a per-mile embodied emissions level that can be applied to Charm-specific journeys using vehicles owned by a transport contractor.
Project	Electricity Use from Injection	Included	CO_2, CH_4, NO_2	The Well Operator is required to provide a monthly report on energy

				usage specific to Charm emplacements. Emissions impact of electricity usage is calculated based on the per kWh emissions for the SPP North grid subregion as reported by the EPA eGrid emissions factors. This is supplemented by a per-kWh addition to account for the emissions associated with grid infrastructure as quantified by a weighted average of power generation sources based on the fuel mix for the subregion reported by the EPA and the associated electricity infrastructure emissions factors reported by GREET
Project	Fuel Use from Injection	Included	CO_2, CH_4, NO_2	The Well Operator is required to provide a monthly report on energy usage specific to Charm emplacements. Emissions impact of fuel usage is calculated based on GLEC models for fuel combustion in terms of TCO2e/kg fuel multiplied by the quantity of fuel reported. This quantity is corrected for fuel pump uncertainty as detailed in the Uncertainty Analysis
Project	Embodied Emissions from Injection Equipment	Included	CO_2, CH_4, NO_2	In the completion of their own PDD, Vaulted, the well operator for this project, reported the embodied emissions associated with the injection equipment on their site divided by the estimated well capacity to arrive at a quantity of embodied emissions per emplaced tonne of material. This value is deducted from the net CDR associated with each tonne of bio oil emplaced by Charm.
Project	Carbon Content of Injected Bio Oil	Included	CO_2	Samples are taken from each injection batch prior to the addition of salt and liquid caustic soda to modify injectate salinity and pH. These samples are sent to an

				analytical laboratory to quantify the carbon content of that batch. The mass of consumables added to each batch is monitored by the site operators. The Total Injectate Mass is measured using a calibrated truck scale at the well site and the Mass of Bio Oil Injected is computed by subtracting the mass of consumables added from the Total Injectate Mass. The Mass of Bio Oil Injected is multiplied by the % C content to compute the gross C sequestered by an injection. See the Monitoring Plan for additional details.
Project	Transport Emissions from Transport of Test Samples to Lab	Included	CO_2, CH_4, NO_2	The number of tests, samples, and sample weights are internally standardized for each injection batch and calculated as reported by the Charm Chemistry and Research teams. Emissions are calculated for air shipment of samples based on a conservative estimate of the point-to-point distance between the sampling site and labs in Google maps. Weight and distance are used to calculate emissions using the GLEC emissions factor for air freight.

Baseline scenario
Please describe the baseline scenario of what would have happened if your Project did not take place (refer to Section 2.5.2 "Baselines" of the Isometric Standard and the requirements outlined in the relevant Protocol). Projects will only be credited for Removals above this counterfactual baseline.
The bio-oil Charm sources from AECN is produced using residues, primarily sawdust, generated by the Arbec lumber mill adjacent to AECN's pyrolysis facility. By purchasing the oil, Charm creates demand that AECN meets by offtaking additional residues from the mill. AECN is jointly owned by the sawmill, Arbec, and wood harvester, Groupe Remabec.The pyrolysis facility was developed as a solution to the ongoing buildup of residues.

This development was, in part, triggered by the closure of other businesses in the region who would have otherwise purchased this byproduct as an input for their own production. Due to the remote location of the mill, the development of economically viable offtake relationships with businesses outside the region is a challenge. This is evidenced by Arbec and Groupe Remabec's decision to invest over $100 million CAD to build out an onsite pyrolysis facility, as well as the accumulation of a large pile of sawdust as sawmill operations continued without an offtaker for residues for a significant period of time. The AECN facility was the solution to this problem.

Because its primary revenue stream is the production of wood boards for construction, the mill would continue to operate and create sawdust and wood shavings absent AECN. There is clear evidence that the historical practice given this condition has been to create the sawdust pile that still exists onsite, so it is reasonable to conclude that these waste products would continue to accumulate in this fashion.

In such a scenario, existing literature suggests that the anaerobic conditions in the center of a pile of sawmill residues would result in the emission of methane, alongside CO2. The high global warming potential (GWP) of methane would likely result in total emissions with a higher GWP over a 15-year period than if all biogenic carbon were released (Pier and Kelly, 1997). Charm's sequestration of the oil made by pyrolyzing this feedstock removes what would otherwise act as the source material for these emissions and permanently sequesters it underground after processing into pyrolysis oil.

A complete characterization of the feedstock and assessment of the GHG storage counterfactual can be found in the Biomass Feedstock Information appendix below.

The project also involves pre-processing of bio-oil at a rented site at AJ's Services in El Dorado, KS and injection of the processed oil into a salt cavern managed by Vaulted Deep in Hutchinson, KS.

Both AJ's and Vaulted are fully operational commercial sites whose footprint and use are not significantly changed by project activities. AJ's is an active oil field services company primarily servicing the local oil and natural gas industry. Project activities have no significant effect on their operations. In order to ensure a conservative estimate of removals, the embodied emissions of all project equipment and work on the site, as well as emissions associated with consumables and energy consumption, is accounted for and amortized against net removals associated with oil processed by Charm at the facility.

Vaulted uses its salt caverns and associated infrastructure for underground waste emplacement irrespective of its relationship with Charm and participation in this project, including their own sequestration work certified under the Isometric Protocol. Charm accounts for all project-specific emissions as a result of emplacement at Vaulted, including a fraction of their equipment embodied emissions in proportion with the use of the equipment for project emplacements.

Details regarding the accounting discussed above can be found in the GHG Statement.

Leakage Assessment
Please give a robust assessment of how you have considered potential increases in GHG emissions outside the defined Project boundary that occur as a result of the Project activity. Where the potential for such Leakage is identified, it must be quantified and deducted from the CO_2 Removals in accordance with the relevant Protocol. Please refer to Section 2.5.4 "Leakage" of the Isometric Standard.
Charm accounts for all potential leakage across all stages of the project. Based on these assessments we have concluded that there is no identifiable leakage related to this project. In general, the highest risk for leakage in bio-oil sequestration projects comes from replacement or land-use change stemming from the feedstock. However, this feedstock is a byproduct from a sawmill whose primary source of revenue is the production of boards which creates residues–sawdust and shavings–that are used in the pyrolysis process. In addition, all wood processed by the mill is harvested from Provincially-owned lands under the Provincial Management Plan for Quebec forests. As a result, offtake of these products does not present a leakage risk as defined by the Isometric Biomass Feedstock Accounting protocol.

Demonstration of Additionality: Financial Additionality
Please describe and provide evidence for how your Project is financially additional. Refer to Section 2.5.3. "Additionality" of the Isometric Standard and the requirements outlined in the relevant Protol.
In order to occur, this project must generate revenue in order to recoup the costs incurred in its activities. The only revenue-generating activity associated with this project is the sale of credits from sequestered carbon. Absent the ability to sell these credits, none of the project activities would be financially viable. In addition, the project does not qualify for a 45Q tax credit. It therefore qualifies as financially additional as defined by Section 2.5.3 of the Isometric Standard.

Demonstration of Additionality: Environmental Additionality
Please describe and provide evidence for how your Project is environmentally additional. Refer to Section 2.5.3. "Additionality" of the Isometric Standard and the requirements outlined in the relevant Protocol.
This project sequesters carbon-rich bio oil produced from a feedstock that would have otherwise produced emissions equivalent to at least the GWP attributable to 100% of its biogenic carbon content. As a result of this activity, the project results in a net removal of atmospheric carbon when considered against the counterfactual scenario and given all related project emissions. It therefore qualifies as environmentally additional as defined by Section 2.5.3 of the Isometric Standard.

Demonstration of Additionality: Regulatory Additionality
Please describe and provide evidence for how your Project is regulatorily additional. Refer to Section 2.5.3. "Additionality" of the Isometric Standard and the requirements outlined in the relevant Protocol.
This project is fully compliant with KDHE Class V UIC regulations, however it is not required by any government regulations. The purpose of the project is to sequester carbon that would have otherwise been returned to the atmosphere in order to generate credits that can be sold to participants in voluntary carbon markets. It therefore qualifies as regulatorily additional as defined by Section 2.5.3 of the Isometric Standard.

Durability Assessment
Please provide justification for how the Project adheres to the durability requirements outlined in the selected Protocol, which may include references to published literature or internal research. You may further expand on the Monitoring approach used to support the claimed Durability assessment in the "Overview of monitoring for durability" section of the next section.
All bio oil injection resulting from this project will occur at the Vaulted Great Plains Facility in Hutchinson, KS. Vaulted has completed their own PDD under the Isometric Biomass Geological Storage Protocol and their durability assessment is copied below: "Vaulted's Great Plains Facility stores the waste in sealed salt caverns 500+ feet underground for permanent (10,000+ year) geologic storage. Neither leakage nor re-emissions of the waste and its carbon content is expected. Durability is expected to exceed much further than 10,000 years. This expectation is based on a combination of direct measurement, and modeling. Vaulted employs a monitoring program both during and post operation which includes regular testing for mechanical integrity of the wells and cavern integrity. This monitoring program enables the confirmation that the cavern is stable and does not have any subsurface leak pathways. This testing is done when a new cavern is opened, during pre-injection, injection, and post-injection operations. Vaulted monitors the displaced brine returned from the cavern for any waste, which is then filtered out and recycled back into the injection stream. The Great Plains Facility employs slurry injection into salt caverns. Salt is an impermeable formation, thus making it an effective method for securely storing waste materials without risk of leakage into surrounding environments. The caverns at the facility exist at depths where waste is no longer buoyant; if the wells have integrity (confirmed using the same techniques as described above) and are property plugged, waste is permanently sequestered. Safe and durable sequestration of waste in salt caverns has been confirmed in literature, including here, here, and here. To further reduce any risks, Vaulted injects at minimal pressure (80 psig at the wellhead, which maintains total pressure – injection plus hydrostatic – below 0.75 psi / ft to the cavern top). This pressure threshold maintains cavern integrity (the triaxial stress capacity of salt is 1 psi/ft of depth).

In addition to direct measurement, the broader literature models durability of Vaulted's sequestration approach. Salt caverns have been identified in the literature as a [viable location for permanent storage of CO2.]"

Monitoring Plan	
Please specify whether this Project will follow the default Monitoring Plan, following the requirements specified in the "Monitoring Plan Requirements" appendix of the relevant Protocol and its associated modules (Option A), or whether a Monitoring Plan will be submitted which may contain additional or modified monitored parameters (Option B). *Additionally, please give an overview of how monitored parameters and/or models will be used to support the assessment of durability. You may also provide any additional information here about how Project monitoring will be conducted.*	
	A – I confirm this Project will follow the default Monitoring Plan, following the requirements specified in the "Monitoring Plan Requirements" appendix of the relevant Protocol and its associated modules
X	B – I have submitted a Monitoring Plan, which meets the requirements specified in the "Monitoring Plan Requirements" appendix of the relevant Protocol and its associated modules, and which describes any additional or modified parameters monitored which deviate from the default Monitoring Plan

Overview of how monitored parameters or models will be used to support assessment of durability. If Option B was selected, please give details of how the monitoring plan adds to or differs from the default monitoring requirements outlined in the Protocol:
 	
Monitoring Plan parameters relevant to the Bio-Oil Geologic Storage module:
1. **Pyrolysis Emissions**
  a. Process Emissions
    i. Energy Inputs (Fuel, Electricity – Feedstock Transport Included)
      1. Our pyrolysis oil vendor has provided an LCA summarizing the emissions associated with energy inputs, including feedstock transport, consumed by their pyrolysis process based on 3 months of operations (Apr-June) in 2023.
        a. The vendor is expected to update the LCA annually, or in light of major operational changes that would be presumed to increase the carbon intensity of production, whichever comes first
        b. This is monitored by ongoing communication with the vendor
    ii. Tailgas
      1. The vendor has not analyzed stack emissions from their pyrolysis process. In absence of direct data, we were provided a modeling of process emissions from the technology in use (Ensyn RTP) processing woody biomass	

prepared for Natural Resources Canada detailing the addition of pyrolysis oil pathways to GHGenius software.

a. The vendor routes all non-condensable gasses to their biomass dryer. Because some portion of the gas is converted to energy at this step, it is likely that actual emissions are below the estimate provided. However, Charm assumes the full quantity of estimated emissions in order to ensure a conservative estimate of removals.

2. The vendor has retained services to directly test stack emissions by the end 2024. The Process Emissions calculation will be updated to reflect that data once it becomes available
    a. The progress on this measurement will be monitored by ongoing communication with the vendor

2. Transport Emissions

a. Bio Oil Transport from Production to Pre-Processing
    i. Transport Emissions are calculated in terms of ton-miles as detailed in the GHG Statement section
        1. Mass is monitored by Bill of Lading, Scale Ticket and Invoice documents provided by the bio-oil vendor.
            a. These values are measured by weighing the offtake truck prior to and after loading on a certified scale
        2. Distance is monitored differently for Truck and Rail transport
            a. For Truck Transport, the origin and destination are entered into Google Maps to obtain a distance value. When multiple routes are presented, the longest route is assumed to ensure a conservative estimate of removals
            b. For Rail Transport, the specific route distance is provided by the transport provider
        3. Ton-miles are multiplied by the appropriate GLEC emission factor based on vehicle type used (tanker truck, railcar)

b. Injectate Transport from Pre-Processing to Injection
    i. Transport Emissions are calculated in terms of ton-miles as detailed in the GHG Statement section
        1. Mass is monitored by Scale Tickets provided by the injection well personnel.
            a. These values are measured by weighing the delivery truck prior to and after injection on a certified scale
        2. To monitor distance, the origin and destination are entered into Google Maps to obtain a distance value. When multiple routes are presented, the longest route is assumed to ensure a conservative estimate of removals
    ii. Ton-miles are multiplied by the appropriate GLEC emission factor based on vehicle type used (tanker truck)

3. Pre Injection Processing

a. Process Emissions
    i. Fuel Use (Diesel)

        1. All diesel is delivered into a single reservoir on site that is used by both power generators and on-site mobile equipment
        2. The quantity of diesel delivered is monitored by the invoices the vendor provides
    ii. Liquid Caustic Soda (LCS) Use
        1. LCS Use is monitored by onsite staff using a flow meter, confirming volume measurements made with standardized marks on the container in which the LCS is delivered
    iii. Consumables Deliveries
        1. Transport Emissions are calculated in terms of ton-miles as detailed in the GHG Statement section
            a. The mass of product delivered is monitored by invoiced quantities, which are either measured in mass directly, or in volume which is converted to mass based on product density.
            b. Distance of the product journey is monitored based on the supplier location. Given this information, the origin and destination are entered into Google Maps to obtain a distance value. When multiple routes are presented, the longest route is assumed to ensure a conservative estimate of removals
        2. Ton-miles are multiplied by the appropriate GLEC emission factor based on vehicle type used (flatbed truck, tanker truck)
    iv. Thermal Oxidizer Emissions
        1. Based on manufacturer specifications and the expert opinion of both internal and external engineers, at the current maximum production levels the site can accommodate, thermal oxidizer exhaust levels are
            a. Far below the levels that would require an air permit
            b. *De minimis* as a potential source of GHG emissions
        2. This parameter is monitored indirectly in terms of site production capacity. Currently, the maximum site production level is gated by sparging tank availability with a maximum processing capacity of approximately 1 tank of bio-oil every 24 hours.
            a. Site changes that increase this capacity, specifically the installation of additional sparging tank(s), will trigger additional measurement of thermal oxidizer exhaust in order to determine air permitting requirements and GHG emissions impact
    v. Other Parameters
        1. The addition of salt to the bio-oil is monitored by site operators using a digital scale. The addition of salt does not contribute to process emissions because the salt is a waste product and the transport emissions associated with its use are already accounted for by the procedure outlined in the Consumables Deliveries section of this plan. However, the quantity is monitored in order to ensure 1) adequate quantity is added to achieve required injectate salinity, and 2) as one

of the mass measurements required to compute the Mass of Bio-Oil Injected based on the Injectate Mass

4. **Injection**
    a. Process Emissions
        i. Energy Inputs
            1. Electricity is the only energy input used during the injection process. The site office and injection equipment are on two different meters. The reading on both meters is noted by site staff prior to and following injection in order to measure the electricity use specific to Project activities
            2. Electricity use for each injection is monitored by onsite staff and reported in a monthly MRV Report that is provided by the injection site operator as required in their service contract
    b. Injectate Characterization
        i. Injectate Mass
            1. Mass is monitored by Scale Tickets provided by the injection well personnel.
                a. These values are measured by weighing the delivery truck prior to and after injection on a certified scale
        ii. Mass of Bio Oil Injected
            1. During bio-oil processing, the mass of consumables added to the bio oil (LCS, salt) are monitored by the site operators for each batch
            2. The mass of consumables added to the bio-oil being processed are subtracted from the Total Injectate Mass to compute the Mass of Bio-Oil Injected
        iii. Injectate C content (%)
            1. Bio-oil is sampled after the sparging process, but prior to the addition of consumables, and samples are sent to an ISO accredited analytical laboratory for the quantification of C content
                a. Bio-oil is sampled at this point in the process because the addition of consumables causes phase separation, which precludes samples from being the "well-mixed and representative aliquot" required by section 7.4.1.1.1 of the Bio-Oil Geological Storage protocol
                b. Per section 7.4.1.1.1 of the Bio-Oil Geological Storage protocol, 3 samples are taken for each injection batch. The C content used to quantify the associated removal(s) is the average of these 3 samples
            2. The injectate C content is computed by multiplying the Mass of Bio Oil Injected by the average C content of the samples as established by lab testing. This is then multiplied by 44/12 to convert the C content to the equivalent in CO2e.
        iv. Other Injectate Characteristics
            1. Each injection batch is sampled after the blending process, prior to injection, samples are sent to an ISO accredited

analytical laboratory for the quantification of the Total Acid Number (TAN) and density of the injectate

2. Upon arrival to the injection site, injectate is tested to establish neutral pH (5.0 or greater) and temperature prior to injection.
    a. Results are provided to Charm on a monthly basis
    b. Injectate will not be injected if the pH reading is below 5.0

c. Reversals
    i. In the event that a gaseous release at the wellhead should trigger a gas monitoring alarm, the well operator has affirmed that they will contact Charm within a 2-hour period.
        1. Charm, Isometric, and the VVB have agreed that it is more appropriate for the well operator to notify Charm regarding a wellhead gas alarm being triggered rather than the VVB as prescribed in Salt Cavern Storage module Section 3.1.1. This is because 1) additional context-specific investigation is necessary to establish whether the triggering alarm is or is not indicative of a reversal, and 2) the well operator has their alarms set to conservative trigger points below levels that would indicate a reportable event so that any anomaly is investigated before it becomes a larger issue.
        2. Any identified reversal will be promptly reported to Isometric and the VVB and investigated by Charm – Reports will be made between 1 and 3 business days from the identification of a gaseous release per Section 5.6.1 of the Isometric Standard
        3. Relevant monitoring data will be included for the next Verification to be assessed by the VVB per Section 5.6.1 of the Isometric Standard and Section 3.1.1 of the Salt Cavern Storage module
    ii. The well operator has installed detectors and alarms for combustible gas, which is the only type of detection system required by the KDHE for their Class V gas detection permit.
        1. The operator is currently in the process of identifying additional detection systems that would indicate the presence of other organic gasses, which would trigger additional investigation and gas characterization to determine whether the gas may indicate a storage reversal or other structural issue with the well
        2. Charm is working directly with the well operator to procure and install these systems.

5. **Ongoing Regulatory Compliance**
    a. All third-party project participants are queried annually to affirm ongoing regulatory compliance
        i. Participants are required to return a signed affirmation of ongoing compliance
        ii. In the event that there is a compliance issue, participants must

        1. Identify the issue, its time of discovery, and a plan for remediation including timeline
    b. Ongoing monitoring of regulatory compliance requirements at the El Dorado pre-processing site are described above in Section 3 Part iv and is dependent on physical modifications to the site in order to increase processing capacity

Monitoring Plan parameters relevant to the Biomass or Bio-oil Storage in Salt Caverns module:

- **c. Pre-Injection (Baseline) Testing**
    - i. Brine pH
        1. Who is Testing?
            - a. Vaulted team
        2. How Frequently?
            - a. Once
        3. How is Testing Performed?
            - a. pH meter
        4. When is Testing Performed?
            - a. Prior to first emplacement
        5. How are Results Recorded?
            - a. Results are reported to and stored by Charm
    - ii. Brine Temperature
        1. Temperature
            - a. Who is Testing?
                - i. Vaulted team
            - b. How Frequently?
                - i. Once
            - c. How is Testing Performed?
                - i. Thermometer
            - d. When is Testing Performed?
                - i. Prior to first emplacement
            - e. How are Results Recorded?
                - i. Results are reported to and stored by Charm
    - iii. Brine Conductivity/Chloride Content
        1. Who is Testing?
            - a. Vaulted team
        2. How Frequently?
            - a. Once
        3. How is Testing Performed?
            - a. Electrical Conductivity meter
        4. When is Testing Performed?
            - a. Prior to first emplacement
        5. How are Results Recorded?
            - a. Results are reported to and stored by Charm
    - iv. Brine TOC Level
        1. Who is Testing?
            - a. Vaulted team
        2. How Frequently?
            - a. Once

3. How is Testing Performed?
    a. On-site use of a TOC analyser or shipment to an ISO-certified analytical laboratory are both acceptable at Vaulted's discretion
4. When is Testing Performed?
    a. Prior to first emplacement
5. How are Results Recorded?
    a. Results are reported to and stored by Charm

v. Wellhead Gas Composition
1. Who is Testing?
    a. Charm team
2. How Frequently?
    a. Once
3. How is Testing Performed?
    a. Gas samples collected at wellhead and sent to ISO-certified analytical laboratory
4. When is Testing Performed?
    a. Prior to first emplacement
5. How are Results Recorded?
    a. Results are reported to and stored by Charm

d. Injectate and Operational Monitoring

i. Injectate pH
1. Who is Testing?
    a. Vaulted team
2. How Frequently?
    a. One sample per day of injection
3. How is Testing Performed?
    a. pH meter
4. When is Testing Performed?
    a. Upon injectate delivery
5. How are Results Recorded?
    a. Results are recorded on the inspection report/weight scale ticket form that is completed upon receipt of the injectate by Vaulted and returned to Charm
    b. Values are input into the Charm Ledger corresponding with the injection batch for storage

ii. Injectate Temperature
1. Who is Testing?
    a. Vaulted team
2. How Frequently?
    a. One sample per day of injection
3. How is Testing Performed?
    a. Thermometer
4. When is Testing Performed?
    a. Upon injectate delivery
5. How are Results Recorded?
    a. Results are recorded on the inspection report/weight scale ticket form that is completed upon receipt of the injectate by Vaulted and returned to Charm

b. Values are input into the Charm Ledger corresponding with the injection batch for storage

iii. Injectate Conductivity/Chloride Content
1. Who is Testing?
   a. Charm Team
2. How Frequently?
   a. For each injection batch
3. How is Testing Performed?
   a. Charm will maintain field notes and records of how much salt is added to each injection batch to ensure compliance with the salinity requirements elaborated by KDHE in the comfort letter issued for bio oil sequestration activities at Vaulted
4. When is Testing Performed?
   a. During injectate pre-processing
5. How are Results Recorded?
   a. Results are recorded by the Charm pre-processing team as a standard part part of production
   b. Values are input into the Charm Ledger corresponding with the injection batch for storage

iv. Injectate Total Acid Number
1. Who is Testing?
   a. Charm team
2. How Frequently?
   a. Every injection batch – Frequency may decrease if data shows significant consistency across batches
3. How is Testing Performed?
   a. Sample is sent to an ISO-accredited analytical laboratory
4. When is Testing Performed?
   a. Samples are pulled prior to injectate delivery and mailed to lab
5. How are Results Recorded?
   a. Lab results are reported to Charm and input into the Charm Ledger corresponding with the injection batch for storage

v. Injectate Density
1. Who is Testing?
   a. Charm team
2. How Frequently?
   a. Every injection batch
3. How is Testing Performed?
   a. Sample is sent to an ISO-accredited analytical laboratory; lab to report results relative to specific temperature
4. When is Testing Performed?
   a. Samples are pulled prior to injectate delivery and mailed to lab
5. How are Results Recorded?

        a. Lab results are reported to Charm and input into the Charm Ledger corresponding with the injection batch for storage

e. Displaced Brine Monitoring

- i. % by wt of Carbon
    1. Who is Testing?
        a. Vaulted team
    2. How Frequently?
        a. Every two weeks for 3 months. If measurements are consistent this can be changed to every month for 6 months, then quarterly for 2 years, and finally every 6 months if results remain consistent.
    3. How is Testing Performed?
        a. On-site use of a TOC analyser or shipment to an ISO-certified analytical laboratory are both acceptable at Vaulted's discretion
    4. When is Testing Performed?
        a. At Vaulted's discretion, provided minimum frequency requirements are met
    5. How are Results Recorded?
        a. Lab results are reported to Charm
        b. On-site measurements will be included in a monthly report provided to Charm by Vaulted per the service agreement between the parties
        c. Documentation of results will be stored by Charm
- ii. Displaced Brine Temperature
    1. Who is Testing?
        a. Vaulted team
    2. How Frequently?
        a. Initially, after each injection. Frequency can be reduced once consistency between samples is statistically proven
    3. How is Testing Performed?
        a. Thermometer
    4. When is Testing Performed?
        a. After injection
    5. How are Results Recorded?
        a. Results are recorded on the inspection report/weight scale ticket form that is completed upon receipt of the injectate by Vaulted and returned to Charm
        b. Values are input into the Charm Ledger corresponding with the injection batch for storage
- iii. Displaced Brine pH
    1. Who is Testing?
        a. Vaulted team
    2. How Frequently?
        a. Initially, after each injection. Frequency can be reduced once consistency between samples is statistically proven

3. How is Testing Performed?
    a. pH Meter
4. When is Testing Performed?
    a. After injection
5. How are Results Recorded?
    a. Results are recorded on the inspection report/weight scale ticket form that is completed upon receipt of the injectate by Vaulted and returned to Charm
    b. Values are input into the Charm Ledger corresponding with the injection batch for storage

iv. Displaced Brine Chloride Content/Conductivity
1. Who is Testing?
    a. Vaulted team
2. How Frequently?
    a. Initially, once per day of emplacement. Frequency can be reduced once consistency between samples is statistically proven
3. How is Testing Performed?
    a. Electrical Conductivity meter
4. When is Testing Performed?
    a. After injection
5. How are Results Recorded?
    a. Results are recorded on the inspection report/weight scale ticket form that is completed upon receipt of the injectate by Vaulted and returned to Charm
    b. Values are input into the Charm Ledger corresponding with the injection batch for storage

f. Cavern Integrity

i. *As the Well Operator, Vaulted is responsible for monitoring all of the following parameters. In addition, Vaulted is responsible for all monitoring and reporting required to maintain their UIC permit.*
1. Internal Well Integrity
2. External Well Integrity
3. Cavern Temperature
4. Cavern Pressure
5. Cavern Volume and Fill (Sonar Survey)
6. Wellhead Gas Composition
    a. Gas Isotope Stability if Wellhead Gas Composition is outside of normal average baseline range
7. Surface Subsidence
8. USDW Quality
9. Salt permeability
10. Porosity and Permeability of caprock and any interbeds
11. Existing subsurface features such as faults

[Optional] Additional information on Project monitoring:

Data collection and storage
Please describe the data collection and storage approach taken, including: ● *How data is transmitted and collected* ● *How data is stored* ● *Length of time for which records are archived* ● *Backup procedures and strategies for identifying and coping with lost or poor-quality data.* ● *Person(s) / organization(s) responsible for measurement and data collection*

1. Data Transmission and Storage – *Note: Additional details on data collection and usage are in the GHG Statement Data section*
    a. Offtake Tonnage
        i. Oil is weighed by vendor using an on-site truck scale. The vendor provides a Bill of Lading, scale ticket and invoice document detailing the total weight
        ii. Mass value is entered into the Ledger using the User Interface (UI) and the document is uploaded with the entry
    b. Process and Embodied Production Emissions
        i. Process and embodied emissions are entered into the Ledger as a static value based on the Vendor LCA (process emissions) and Charm calculations (embodied emissions) and applied to each MT of bio oil purchased
    c. Transport Emissions
        i. Fuel Emissions
            1. Point-to-point distances are stored in the Ledger based on the distance provided in Google Maps, in the case of trucks, or the rail carrier, in the case of trains
                a. In order to ensure a conservative estimate of removals, the longest route is selected when multiple routes are provided
            2. The cargo weight (data collection process described above), vehicle type and point-to-point distance for the journey is used in conjunction with GLEC emissions factors to calculate transport Fuel Emissions
        ii. Embodied Emissions
            1. Trucking
                a. Per-mile embodied emissions for the vehicle type (Heavy Duty Vehicle) are entered into the ledger as a static value and applied to each journey based on mileage accounted for by stored point-to-point distances between sites
            2. Rail
                a. Per-mile embodied emissions for the vehicle type (Railroad Rolling Stock) are entered into the ledger as a static value and applied to each journey based on

mileage accounted for by stored point-to-point distances between sites

d. Pre-Processing Site Emissions
    i. Fuel Use
        1. Fuel use is measured based on amounts purchased (delivery invoices) and entered into the ledger via User Interface.
    ii. Electricity Emissions
        1. The pre-processing site is not yet on grid power. Should this change, meter readings will be taken at regular intervals and usage data will be entered into the Ledger via User Interface
    iii. Equipment Embodied Emissions
        1. Embodied emissions are calculated based on the expected useful life of the equipment and amortized against removals as a straight-line depreciation for each reporting period.
    iv. Consumables Embodied Emissions
        1. Liquid caustic soda (LCS) is added to the bio oil at a volume measured by on-site staff using a flow-meter. The quantity added to each injection batch is recorded by site staff and entered into the Ledger via User Interface.
    v. Consumables Delivery Emissions
        1. Origin and weight of delivery are recorded by site staff and entered into the Ledger via User Interface. This provides the data necessary to calculate transport emissions as detailed in the GHG Statement
    vi. Salt Addition to Bio-Oil
        1. Salt is added to the bio oil at a volume measured by on-site staff using a scale. The quantity added to each injection batch is recorded by site staff and entered into the Ledger via User Interface.

e. Injection Emissions
    i. Energy Use Emissions (Fuel and Electricity)
        1. The Well Operator is required to provide a monthly report on energy usage specific to Charm emplacements. These values are input into the Ledger as received via User Interface
    ii. Injection Equipment Embodied Emissions
        1. Embodied emissions are entered into the ledger as a static value based on Vaulted's PDD and relevant GREET emission factors and applied to each MT of bio oil emplaced
    iii. Sampling Emissions
        1. Pre-injection sampling is executed at a pre-determined cadence for each injection batch. Emissions are calculated according to the number of tests and associated transport emissions required to test each batch. This value is entered into the Ledger as a static value and applied to each injection batch of bio oil emplaced

2. How Data is Stored
    a. Ledger data is stored in an AWS relational database. It is backed up in S3, a service for storing files.
3. Length of Time for Which Records are Archived

   a. Most data is stored indefinitely in the AWS database. In the unusual case where data is deleted, it will be stored in backups on S3 which enables retrieval even after deletion.
4. Backup Procedures and Strategies for Identifying and Coping with Lost or Poor-Quality Data
   a. Charm maintains daily snapshots of the relational database for the past 30 days.
   b. All objects are backed up on S3, enabling retrieval even after an update or deletion
5. Person(s)/Organization(s) Responsible for Measurement and Data Collection
   a. Charm Industrial
      i. Variable data is entered by Charm staff based on relevant documentation such as bills of lading, receipts for fuel purchase, etc.
   b. Vaulted
      i. Vaulted is required by their service agreement to provide to Charm with a monthly report including
         1. Weight of product delivered by Charm as documented by weight scale tickets
         2. Energy consumed on site associated with the processing and injection of product delivered by Charm
      ii. Vaulted will also provide inspection/receipt reports for each injectate delivery including
         1. Weight of injectate delivered
         2. Injectate pH
            a. 1 sample per day of injection
         3. Injectate temperature
            a. 1 sample per day of injection
   c. AECN
      i. AECN is responsible for taking measuring and recording the weight of bio oil to be delivered to Charm as documented by a Bill of Lading
      ii. AECN has also provided an updated production LCA measuring the process emissions associated with their production of Bio Oil

Notes on Charm's Ledger software

In this section and elsewhere in the PDD, reference is made to the Ledger. This is a piece of proprietary software developed internally by Charm's software team. Once a given batch of bio-oil comes into Charm's custody, as defined by issuance of a Bill of Lading, scale ticket and invoice document as discussed earlier in this section, the batch becomes a "Lot" in the Ledger.

The software is designed to measure and track Lots as they are split and combined, maintaining a clear mass balance and chain of custody as they move between transport modes (e.g. truck to railcar to truck) and are stored, batched, and treated along the pathway to injection. Once a given Lot, or batched combination of several split Lots, is injected it is then logged as a Removal. The data for a given Removal includes the process emissions associated with the Lot components, calculated on a mass balance basis which traces back to the original Lot.

The Ledger also captures data from "site emissions", described in Appendix 2, which are facility emissions that cannot be neatly mapped to a specific Lot (e.g. site electricity usage). When a Removal is completed, the CHN testing associated with that removal assigns it a C and CO_2e content, from which both process emissions and a portion of site emissions for the reporting period in which the Removal is claimed, are deducted in order to compute the Net CDR for a given Removal

Data Quality Assurance Measures

Note: Data quality assurance is an ongoing process. The following is a list of measures currently place, which is sure to grow as operational experience demonstrates optimization opportunities:

1. Removals are calculated and removal data is managed within the Charm Ledger. This specialized piece of software improves data quality by
    1. Ensuring that emissions factors and measurements are used consistently across all estimates
    2. Ensuring that calculation methods are used consistently across all estimates
    3. Ensuring consistent amortization of embodied and site emissions
    4. Reducing human error by automating calculation work such as unit conversions
    5. Reducing human error my minimizing the amount of manual entry required to generate estimates
    6. Allowing for multiple layers of manual testing and review of functions by both internal and external parties
    7. Requiring specific documentation such as bills of lading, mass documents, routing documents, documentation for emission factors/carbon intensities, etc. for entries
        1. Documents are also archived separately for ease of reference
2. Where possible, data is sourced from documents that provide an additional layer of oversight/quality control (e.g. official bills of lading, official invoices, direct-printed scale tickets from calibrated scales)
    1. When data from such documents is entered manually, the document must be provided as a check against entry errors
3. Datapoints requiring manual entry by operators are minimized. Where they are necessary, operators are trained on specific entry procedures. Opportunities for error are further minimized by eliminating cumbersome/complex entry requirements wherever possible.
4. Datapoints are double-checked by Charm's MRV team prior to Ledger entry to catch and investigate potential indicators of errors and nonconformities
5. Because data quality can never be fully guaranteed, high-sensitivity parameters are specifically modified for uncertainty as detailed in the Uncertainty Assessment and Sensitivity Analysis

Reversals
Please complete a reversal risk assessment for your Project, including consideration of the guidance in the Risk of Reversal Questionnaire below.
Overall risk of reversal (based on risk reversal questionnaire score; please select one): **Very low (0)** Low (1-3) Medium (4-5) High (>6)
[Optional] Additional details/assessment of reversal risk mechanisms: Vaulted has assessed this injection site to present a "very low" risk of reversal and manages their own monitoring plan to ensure containment integrity over time. In addition to the monitoring program described above, Charm's use of pyrolysis oil significantly reduces the risk of methane production arising from anaerobic decomposition of organic materials. Because pyrolysis is a reaction that occurs in a high-heat, low oxygen environment, the oil does not contain compounds that would support the microbial life required for anaerobic decay. This is confirmed by a peer-reviewed chemical characterization of pyrolysis bio-oil from multiple feedstocks (Negahdar et al., 2016) and a specific analysis of pyrolysis oil commissioned by Charm that are included in the supporting documents for this PDD

#	Question	If answered "Yes"	If answered "No"	Response
1	Is a reversal directly observable with a physical or chemical measurement as opposed to a modeled result?	Proceed to questions 2-8	Proceed to questions 7-8	Yes
2	Is the carbon being stored in a closed or impermeable system? (e.g., salt cavern)	Proceed to questions 10-11	Proceed to questions 3-11	Yes
3	Is the carbon being stored organic?	Add 1 to Risk Score		N/A

4	Does scientific consensus suggest that the carbon storage reservoir has a less than 10,000 year durability?	Add 1 to Risk Score		N/A
5	Is methane production a Project risk?	Add 1 to Risk Score		N/A
6	Does this approach have a material risk of reversal due to natural disasters including, but not limited to, floods, storms, earthquakes, fires, etc.?	Add 1 to Risk Score		N/A
7	Does this approach have a material risk of reversal due to human-induced events from outside actors, such as change in farming practices, change in ownership and management of Project sites, or similar?	Add 1 to Risk Score		N/A
8	[Applicable only for subsurface storage] Is the carbon being stored in the deep subsurface with multiple trapping mechanisms preventing reversals? (e.g., multiple confining layers, CO_2 dissolves or solidifies)	Minus 1 to risk (unless 0)		N/A
9	Is there 10+ years of monitoring and/or lab data demonstrating low project risk?	Minus 1 to risk (unless 0)		N/A

10	Does this pathway have a documented history of reversals?	Please consider the frequency and severity of previous reversals, and the shared characteristics between documented reversals and the present project. For pathways with no documented history of reversals, add 0 to the Risk Score. For pathways with a history of frequent reversal, add 2 to Risk Score. For pathways with a limited history of reversals, add 1 to Risk Score.		0
11	Is there one or more Project-specific factors that merit a high risk level?	Please consider the number and severity of risks identified. If one low or medium severity risk is identified, add 1 to Risk Score. If multiple risks are identified, or if any high severity risks are identified, add 2 to Risk Score		0
Total Risk Score				0

Uncertainty assessment	
Specify how uncertainty is considered, and how removals are to be conservatively estimated, in accordance with Section 2.5.7 "Uncertainty" of the Isometric Standard.	
Please specify which option(s) were used in consideration of uncertainty (*one or multiple options*).	
	Conservative estimate of input parameters
X	Variance propagation

	Monte Carlo Simulations
Please provide a sensitivity analysis. A sensitivity analysis is provided in the GHG Statement doc appended to this PDD	
●	I have uploaded a sensitivity analysis in accordance with the guidance in the Isometric Standard

Justification for your choice of uncertainty approach:
A Sensitivity Analysis has been carried out for each measured emissions source/parameter based on a Sample Calculation of one truckload of bio oil originated at AECN and transported to Kansas for Injection.

In the Sensitivity Analysis, the value of each source was arbitrarily increased by 20%, a value far higher than a reasonable expectation of measurement variance for any given parameter. These changes are compared against an estimated “Sample Removal” without this variance. Any parameter that, when increased by 20%, contributed to a change in the estimated removal that was greater than 1% of the original estimation was then subject to an Uncertainty Analysis, as specified in Section 2.5.7 of the Isometric Standard.

Parameters Identified as requiring Uncertainty Analysis are listed below, along with a brief summary of the approach to identifying and measuring the associated measurement uncertainty. All calculations are included in the Uncertainty Analysis sheet included in the GHG Statement Supplemental Doc appended to this PDD.

1. Bio Oil Process Emissions
    a. Process Emissions from the Vendor LCA are treated as an emissions factor for the process – Like other emissions factors, they are based on a study of the production data and emissions associated with the production of bio oil by AECN
        i. An Uncertainty Factor has been calculated for this emissions factor based on process and data quality considerations as outlined in Section 7.4 of the Isometric Standard.
        ii. This Uncertainty Factor is included as an increase in the baseline emissions factor to ensure a conservative estimate of removals. This is shown in the Emissions Factors sheet in the GHG Statement Supplemental Doc appended to this PDD
2. Bio-Oil Transportation Fuel Emissions
    a. Transportation Fuel Emissions are calculated on a ton-mile basis using GLEC emissions factors. There is no Uncertainty Factor calculated for this value. This is due to previous consultations with Isometric confirming that the GLEC factors are based on millions of miles of data, driving uncertainty down to a negligible value
    b. Routing is based on the point-to-point distance provided by Google Maps (for trucks) or the rail service provider (for rail) for a given route. When multiple routes are given, Charm will use the longest option in order to ensure a conservative estimate of removals.
    c. The maximum allowable error for a legal-for-trade truck scale is 160 lbs for a fully-loaded truck. Bio oil is weighed twice: once when loaded for

delivery at AECN, and once prior to injection at Vaulted. In order to ensure a conservative estimate of removals, Charm reports 1 standard deviation of uncertainty for each scale measurement, using 160 lbs as the half-width of a uniform distribution of scale error. The uncertainty in the bio oil weight is propagated to the calculation of transport emissions and all downstream calculations.

3. Bio Oil Pre-Processing Fuel Emissions
    a. Bio Oil Pre-Processing fuel emissions are calculated on a per-gallon basis using fuel purchase records and GLEC emissions factors. There is no Uncertainty Factor calculated for this value. This is due to previous consultations with Isometric confirming that the GLEC factors are based on millions of miles of data, driving uncertainty down to a negligible value
    b. The maximum allowable error for a legal-for-trade fuel meter is .28%. In order to ensure a conservative estimate of removals, Charm reports 1 standard deviation of uncertainty for each fuel delivery, using .28% as the half-width of a uniform distribution of meter error. The uncertainty in the fuel quantity is propagated to the calculation of fuel use emissions for bio oil pre-processing operations.
4. Bio Oil Pre-Processing Consumables Emissions
    a. The consumables used in pre-processing are liquid caustic soda (50%) (LCS) and salt.
        i. Liquid Caustic Soda
            1. The volume of LCS addition to each injection batch is measured by Charm site staff using a flow meter confirming volume measurements made with standardized marks on the container in which the LCS is delivered
            2. Embodied emissions are calculated based on the GREET emissions factor for the product
            3. An Uncertainty Factor has been calculated for this emissions factor based on process and data quality considerations as outlined in Section 7.4 of the Isometric Standard.
            4. This Uncertainty Factor is included as an increase in the baseline emissions factor to ensure a conservative estimate of removals. This is shown in the Emissions Factors sheet in the GHG Statement Supplemental Doc appended to this PDD
            5. In their study of water flow meter measurement uncertainties, Dias, Filho, and de Lucca (2013) identified 2.045% as the uncertainty for a calibrated flow meter. Because the site operations team is in the process of identifying which model of flow meter best fits their needs for the long term, this value will be used as the uncertainty assumption for LCS flow meter measurement until a manufacturer's specific uncertainty rating can be used for the long term. In order to ensure a conservative estimate of removals, Charm reports 1 standard deviation of uncertainty for each addition of LCS to a batch of bio-oil, using 2.045% as the half-width of a uniform distribution of meter error. The uncertainty in the

fuel quantity is propagated to the calculation of fuel use emissions for bio oil pre-processing operations.

ii. Salt

1. Embodied emissions for salt are not included in the PDD due to the fact that the salt is a waste product. It is off-spec/non-saleable salt produced as a waste product incidental to the salt production process at a nearby Morton salt factory

5. Gross CO2e Sequestration
    a. Gross CO2e sequestration is calculated using the following procedure described in the Monitoring Plan. The Bio-Oil is sampled for CHN testing by an ISO accredited laboratory after the completion of Sparging. The % C reported by the laboratory is multiplied by the Mass of Bio-Oil Injected. That value is multiplied by 3.67 or 44/12 to convert the carbon content to CO2e.
    b. The maximum allowable error for a legal-for-trade truck scale is 160 lbs for a fully-loaded truck. The relative standard deviation reported by the manufacturer of the LECO instrument used to measure carbon is .4%. Each of these values are used as the half-width of a uniform distribution of error for their respective associated measurements. These uncertainties are propagated to the calculation of the gross quantity of CO2e sequestered for each injection batch.

Use of Models

Please describe your use of models (if any) for quantification, monitoring, and meeting specified Protocol requirements. Describe the specific model and simulations used, with enough detail so that the work could be replicated.

Please provide model validation results to demonstrate model accuracy, and include an assessment of model uncertainty.

The vendor has not analyzed stack emissions from their pyrolysis process. In absence of direct data, we were provided a modeling of process emissions from the technology in use (Ensyn RTP) processing woody biomass prepared for Natural Resources Canada detailing the addition of pyrolysis oil pathways to GHGenius software. These values have been provided as documentation alongside this PDD.

Values associated with this model are provided in the GHG Statement Supplemental Doc and are incorporated into the Process Emissions emission factor for pyrolysis.

[Storage Module] Storage well overview

Please describe the storage well used and complete the following information.

Charm is emplacing bio oil at Vaulted’s Geat Plains storage well for this project. For that reason, what follows in this section is a reproduction of the Storage Well Overview from their PDD: Storage well description: “Vaulted operates a built and permitted injection well site in Hutchinson, Kansas. This site is a network of 60 salt caverns, with the total capacity to hold 2-3 million metric tons of organic waste. The wells are permitted under Class UIC V well permits by KDHE.”
Monitoring overview (*please summarise the current monitoring in place, as required by the well permit and in accordance with the protocol monitoring requirements. You may provide more information on individual monitoring parameters in the Project Monitoring Plan):* “Charm has contracted with Vaulted for well operations related to this project. The following is quoted from the Storage Well Overview section of the Vaulted PDD: Vaulted is responsible for ongoing monitoring of the injection site per our service agreement and the UIC regulatory requirements incumbent on them as well operators. At the Great Plains Facility, Vaulted maintains a robust monitoring program. Vaulted employs a variety of direct (logging, monitoring, wireline, analysis of well returns, pressure testing) and indirect methods (simulation studies) to confirm containment of injected materials and their decomposition products if any during operations and during project Decommissioning. This includes real time data acquisition of the injection and post injection pressure data. Vaulted also takes periodic measurements, such as depth checks, and sonar or other surveys, which provide a second method for confirming the same containment. At the Great Plains Facility, pressure gauges at the injection wells and monitoring wells on the facility boundary allow Vaulted to ensure no material escapes the caverns. Regular surveys and depth checks are conducted within the cavern wells to understand remaining capacity and to ensure injected materials are accounted for. Vaulted regularly interfaces with the Kansas Department of Health and Environment (KDHE), particularly their Underground Injection Control Division. Monthly and quarterly reports are submitted to KDHE showing that the site is running safely, including data on groundwater quality, emplaced material spec, volume of injected material, and pressures and stability in the subsurface caverns. Vaulted has a strong ongoing relationship with KDHE, with monthly calls to ensure they’re comfortable with the facility. Additionally, the US EPA issued a comfort letter on June 19, 2018 attesting to the safety of Vaulted’s slurry injection technique and the appropriateness of using Class V wells for organic waste injection.”
Storage well location (Address / GPS coordinates): 37.966, -97.941

EPA Well Class: V
Permit number: KS-05-155-003
Permitting authority: Kansas Department of Health and Environment (KDHE)
Permit validity start date: 2022/08/02
Permit validity end date: 2027/08/02
Well storage capacity (total): 2-3M metric tons of wet organic waste
Well storage capacity (used): <10,000 metric tons of wet organic waste
Well storage capacity (available): 2-3M metric tons of wet organic waste

Section C – Duration & Crediting Period

Project timeline
Please indicate the projected start date of your Project and, if applicable, its expected operational closure date.
Start date of Project: 2024/12/03
[Optional] Expected operational closure date of Project:

Project closure
Please describe the conditions under which the Project will be considered closed, and describe the Project Closure Plan – outlining any post-cessation actions that will be undertaken upon Closure of the Project.
Definition of Project cessation: Once Vaulted indicates that cavern is at capacity, or Charm decides to cease injection at Vaulted's Great Plains Cavern facility, whichever comes first.
Closure Plan: In either case, Vaulted is responsible for the closure and/or ongoing monitoring of the cavern after Charm has ceased operations at the facility. Vaulted has accounted for their closure methods: "As a cavern reaches its capacity, Vaulted shuts the well in and places the cavern on monitoring status (post-injection monitoring) for a period of time to confirm the well is static and to comply with KDHE rules. Once the appropriate post monitoring period is complete, each at-capacity cavern will be plugged with cement in a manner that prevents the movement of fluids either into or between underground sources of drinking water (USDW)."

Crediting Period
Please indicate the planned start date and duration of your crediting period. The crediting start date may either be your Project's start date or up to two years prior to design submission, whichever is later. Unless otherwise specified in the relevant Protocol, the maximum crediting period is 5 years.
Start date of crediting period: 2024/12/03
Total length of crediting period: 5 years

Section D – Environmental and social impacts

Analysis of environmental and social impacts	
Please provide an assessment of the environmental and social impacts of the Project, in accordance with Section 3.7 "Environmental and Social Impacts" of the Isometric Standard. *For each aspect of the assessment, demonstrate how the risks have been assessed and if applicable, what mitigation plan is in place to prevent them. If some aspects are not applicable to your project, justify how you determined it.* *A full Environmental and/or Social Impact Assessment (EIA and/or SIA) is only required if impacts are considered significant and/or if required by the host jurisdiction.*	
	[Optional] I have attached a full EIA document.
	[Optional] I have attached a full SIA document.
X	I acknowledge responsibility for reporting potential environmental and social impacts identified to Isometric and environmental regulators
Environmental Impacts	
Resource efficiency and pollution prevention, including pollutant emissions to air, pollutant discharges to water, noise and vibration, generation of waste and release of hazardous materials, chemical pesticides and fertilizers.	
X	Above risks are applicable to this Project
	Not applicable to this Project
Environmental impacts need to be considered with respect to the "upstream" processes of bio oil feedstock harvest and pyrolysis, as well as the impacts of the injection site.	

Biomass Feedstock and Pyrolysis

The primary environmental impacts upstream of injection are related to the biomass feedstock used for pyrolysis and the process of pyrolysis itself. AECN has gone to significant lengths to ensure that both the biomass feedstock and the pyrolysis process reflect their dedication to sustainability.

All of the wood used as pyrolysis feedstock is harvested from provincially-owned forests in accordance with rights granted under the Quebec Provincial Management Plan (PMP). The PMP is explicitly guided by “sustainable forest management objectives” which dictate the bounds of allowable harvest such that the ecological integrity of provincial forestland is maintained over time.

In addition, the Bureau de Normalisation du Québec, an official certification organization accredited by the Standards Council of Canada, has granted the biomass harvester a certificate of compliance with the SFI Forest Management Standard.

The pyrolysis process itself has also been engineered with sustainability in mind. The facility construction was financed in part by Sustainable Development Technology Canada and Department of Natural Resources Canada. The facility is also certified by SGS Germany as compliant with the EU International Sustainability and Carbon Certification standard and the requirements of Renewable Energy Directive (RED) II.

Bio-Oil Injection

Vaulted, the injection well operator, has completed all necessary pre-injection studies and analyses to ensure risks to local resources and environment have been appropriately assessed and eliminated or controlled. Charm’s contract with Vaulted stipulates that Vaulted has operated and will continue to operate in compliance with all local regulatory requirements.

Please see Vaulted’s Environmental Impacts assessment below:
“All necessary pre-injection studies and analyses were conducted before the facility was built, including geologic feasibility studies, local environment and groundwater assessments, and engagement with local community groups and regulators. The Great Plains Facility is already fully permitted and operational.

The Great Plains Facility underwent environmental assessment prior to securing Class V injection permits. The assessment found no material environmental issue with the site.

Regular monitoring is undertaken at the facility, including:
- Quarterly groundwater testing to ensure no groundwater contamination
- Lab analysis on all emplaced material to ensure complies with non-hazardous organic permit
- Monthly reporting on total volume of emplaced material
- Daily readouts of pressures and stability of the subsurface caverns
- Bi-yearly elevation surveys to ensure ground stabilization (and no cavern sinking is occurring)”

Biodiversity conservation and sustainable management of living natural resources, including terrestrial & marine biodiversity and ecosystems, protecting habitats of rare & endangered species, avoiding conversion of natural forests, grasslands or wetlands, minimizing soil degradation or erosion, minimizing water consumption and stress.	
X	Above risks are applicable to this Project
	Not applicable to this Project
Biomass Sourcing and Pyrolysis As discussed above, all biomass sourcing occurs under the auspices of the Quebec Provincial Management Plan for forests and is certified by SFI. Both the PMP and the SFI Standard require that the natural resources of forestland are managed sustainably with respect to both plant and animal life. **Bio-Oil Injection** The above discussion of Vaulted's rigorous monitoring of their site extends to these considerations as well. Their ongoing efforts help to ensure against negative impacts on the surrounding ecosystem due to potential risks presented by the injection site. In addition, the Class V injection permit issued by KDHE entails compliance with EPA Underground Injection Control regulations. Because emplacement is occurring at Vaulted's Great Plains Facility, please reference their account below: "The Great Plains Facility underwent environmental assessment prior to securing Class V injection permits. The assessment found no material environmental issue with the site."	
Social Impacts	
Labor rights and working conditions, including providing safe & healthy working conditions for employees, fair treatment and equal opportunities in your organization; considerations of prevention of forced labor, child labour or trafficked persons protecting workers employed by third parties. This is required for all Projects.	
X	Above risks are applicable to this Project
Charm has a robust Environmental Health and Safety department which ensures a safe and healthy working environment at all Charm facilities including required staff participation in safety training and the provision of task-appropriate PPE. As operations grow and change, additional training and equipment are proactively provided in order to ensure continued high safety performance. A culture of openness and communication around safety and hazard identification is encouraged and reinforced. It is Charm's company policy that any employee or contractor who feels a process is unsafe is encouraged to stop work, communicate the issue to appropriate managers, and not resume work until the issue is resolved. Charm pays living wages for all employees at all facilities.	

Third-party partners (AECN and Vaulted) are duly licensed businesses in good standing within their jurisdictions. In both cases, this status means they are governed by laws and regulations which stipulate against practices such as forced labor, child labor, and the employment of trafficked persons.	
Land acquisition and involuntary resettlement in the context of your deployment site selection	
X	Above risks are applicable to this Project
	Not applicable to this Project
With one exception, all land involved in this project is owned and operated by entities other than Charm with whom Charm has contracted for specific goods or services. Charm's engagement of these entities for the purpose of this project does not impact land use or acquisition in any material way. That being said, no known involuntary resettlement has occurred due to any third-party commercial activities. The exception mentioned above applies to the site in El Dorado, KS which Charm rents from AJ's Services for the purpose of pre-processing bio oil to ensure suitability for injection. AJ's Services is an established oil field services company and the land they own has been a long-standing site for continuous commercial operations. Its footprint is not changed by Charm's rental of space within the facility. No known involuntary resettlement has occurred due to the development of this site.	
Environmental and social justice, Indigenous Peoples, Local Communities, cultural heritage, human rights and gender equality (equal opportunities and pay), as it relates specifically to deployment site selection.	
X	Above risks are applicable to this Project
	Not applicable to this Project
There are no known environmental or social justice risks that result from Charm's pre-processing site rental or arising from third-party sites that Charm has contracted with for the purposes of this project. All sites have been long-established as commercial operations and Charm's work does not create a meaningful change in site usage that would impact local communities or natural environments. Charm and all third-party partners operate in good standing above and beyond the regulatory requirements for human rights, worker safety and nondiscrimination.	

Additional risks	
In addition to the above areas of environmental and social impacts, I attest that further risks of potential harm arising from the Project have been assessed, and [please select one below option]:	
X	A) No such additional risks have been identified

	B) For any such risks identified, appropriate risk mitigations have been put in place and are detailed below.

Please describe any such risks identified, and the corresponding risk mitigations which have been put in place.

As this PDD has demonstrated, project operations primarily rely on Charm's contracting of products and services with third-party providers. The production of the bio-oil itself, its transportation and sequestration via underground injection are all achieved by the continued operations of established businesses whose commercial model is based on the provision of these products and services. As such, Charm's work with these providers does not entail a significant change in their behavior or the assumption of additional risks beyond those associated with their normal operations independent of Charm's intervention. Therefore, we have not identified any additional risks associated with this project.

The sole partial exception to this characterization is Charm's development of a pre-processing facility at AJ's Services in El Dorado, KS. This development involved pouring a concrete pad and standing up infrastructure for blending and sparging bio-oil prior to injection in order to ensure all injectate is compliant with KDHE and Class V Injection Permit requirements.

However, this development is both modest and not an identifiable source of additional risk beyond what is already present at AJ's site. AJ's Services is a long-standing oil field services company and the site has been an established staging area for industrial processes associated with the local oil and gas industry. Charm's activities do not materially change the risks and impacts inherent in the operation of the facility.

For these reasons, there are no additional risks that have been identified as part of this project.

Sustainable Development Impact

Please explain in the below table, where relevant, which Sustainable Development Goals (SDGs) other than SDG13 ("Climate Action") your Project has a positive impact and how this is consistent with the SDG objectives of all jurisdictions in which you operate. If applicable, please include information on any data and parameters monitored before or during the crediting period.

Please see here for a full list and details of all 17 SDGs.

#SDG with name	Description of project impact	Description of alignment with goals of jurisdiction(s), if relevant and applicable	If applicable, unit of measurement (e.g. removal credits, MWh)

8: Decent Work and Economic Growth	Charm's project activities create employment opportunities for living-wage jobs in a work environment that prioritizes safety. See "Labor Rights and Working Conditions"		
9: Industry, Innovation, and Infrastructure	By creating a demand for and sequestering pyrolysis oil, Charm's activities in this project support the development of an industrial infrastructure to remove GHGs that would have contributed to atmospheric warming at scale in the likely counterfactual scenario		
11: Sustainable Cities and Communities	By creating a demand for AECN's pyrolysis of wood residues associated with the production of wood boards for construction and sequestering the carbon associated with production process wastes the project contributes to the sustainability of cities and communities		
12: Responsible Production and Consumption	By creating a demand for AECN's pyrolysis of wood residues associated with the production of wood boards for construction and sequestering the carbon associated with production process wastes the project makes the consumption of these wood products more sustainable		
Please explain whether you assessed the SDG impact of your project prior to this			

qualitative reasoning. If so, please describe if and which standardized assessment tools and methods you relied on.
There has not been a formal assessment of SDG impacts – The qualitative content above is based on baseline project functions.

E – Stakeholder Input Process

Stakeholder Input Process Summary
Please provide a description and documentation of how comments by local stakeholders have been invited and compiled, a summary of comments received, and report on how due account was taken of comments received. Refer to Section 3.5 "Stakeholder Input Process" of the Isometric Standard for full requirements.
Part of the rationale for Charm's decision to emplace bio oil at Vaulted's Great Plains cavern facility is their strong standing in the local community and commitment to social responsibility as cavern operators. Because Charm's work with Vaulted does not require any significant modification of their operations in a manner that would impact local stakeholders, their due diligence also extends to this project, which Charm has contracted with Vaulted in order to undertake. Please see Vaulted's summary of their Stakeholder Input Process below: "At the Great Plains Facility, multiple sessions were held to solicit feedback from the surrounding community on the site. A site tour was conducted as well as two community meetings held to address concerns and questions. The main voiced question was to inquire about job opportunities at the site. The second question was around maintaining safe drinking water at and around the site. The community was told about the regular monitoring for containment of the formation and the regular groundwater checks. In general, for future wells, Vaulted sees working with local communities, governments, and other stakeholders as essential to both scaling CDR work and ensuring maximum positive social and environmental impact. Generally, stakeholders include: - Local, state, and federal regulators (generally, state and local EPA) - Members of local government - Nearby residents and landowners (especially within the anticipated radius of injectate migration / influence) - The waste partners from whom Vaulted offtakes the waste - Environmental interest groups / NGOs Vaulted engages with each of these stakeholders across the lifespan of the work of the site - before Vaulted even begins the well permitting process. Before any steel is in the ground, Vaulted submits detailed well plans to the regulators at the start of the permitting process, holds community meetings to answer questions, and works with waste partners to finalize offtake. Vaulted continues to engage each stakeholder throughout the project - as Vaulted secures the permit, builds the well, and operates it on an ongoing basis. Vaulted's sites require regular re-permitting and regular reporting to regulatory and local

government agencies, the outputs of which are publicly available. These activities generally entail public engagement via notices, hearing, regular quantification and reporting of net environmental impacts, and public access. The cadence of these activities provides Vaulted with regular input from the public via their elected representatives, responses to public notices, feedback from public presentation, and other vehicles."

Grievance Mechanism

Please outline the mechanism for stakeholders to voice, process and resolve grievances.

The above response also addresses the question of a grievance mechanism for the surrounding community. Because Charm's activities do not constitute a material change to Vaulted's operations, Vaulted's established grievance mechanism also applies to this project. Please see below for Vaulted's summary of their grievance mechanism:

"In the Great Plains Facility, Vaulted regularly interfaces with the Kansas Department of Health and Environment (KDHE), particularly their Underground Injection Control Division.

Vaulted submits monthly and quarterly reports to KDHE showing that the site is running safely, including data on groundwater quality, emplaced material spec, volume of injected material, and pressures and stability in the subsurface caverns. Vaulted has a strong ongoing relationship with KDHE, with regular calls and site visits to ensure they're comfortable with the facility's operations. Vaulted has also engaged with federal, local and county representatives, as well as residents and landowners proximate to the site.

Because the site is in a small community rural setting, Vaulted made neighbourhood outreach a top priority. Vaulted engaged the community before filing for permits at the project definition stage, throughout the permitting process, and once the permit was issued before commencing operations. These touch points included when the landowner originally permitted the site for waste emplacement, as well as when Vaulted filed for an organic waste permit in 2021 year through Advantek, Vaulted's incubating company. In both cases, Vaulted/Advantek used county records to identify interested parties, sent letters to the nearby residents and landowners, hosted open houses (information sessions and site tours). On each occasion, Vaulted had local regulators from KDHE and local government officials present. Additionally, Vaulted posted the facility permits into the federal register and other publications as applicable to provide adequate public notice and opportunities for feedback, engagement, or protest.

For any issues or questions that arise community members and other stakeholders can reach out to the facility via phone at 620-662-6367."

Appendix 1: Biomass Feedstock Information

This Appendix must be completed for each feedstock type and feedstock provider used in this Project.

Feedstock Summary
Please describe your Feedstocks used.
The biomass feedstock used for this Project is sawdust and shavings from a lumber mill adjacent to the bio-oil provider, AECN. Groupe Remabec, which is a co-owner of AECN, harvests trees from publicly-owned forests in accordance with rights granted by the Province of Quebec under the Provincial Management Plan (provided as supporting documentation for this Project). The harvest activity is also SFI-certified through the Bureau de Normalisation du Québec, a copy of the certificate is also provided as additional documentation. The sawdust and shavings are a byproduct of the Arbec sawmill's production of wood boards, which are the primary revenue source for the mill. A small portion (10%) of the feedstock consists of chipped unmerchantable roundwood that had been previously harvested and transported to AECN.

Feedstock Hazardous status
Please describe how you are demonstrating that the feedstock you are using is not hazardous. This may either be done by providing evidence from tests of the feedstock or by providing evidence that the relevant injection permits only allow non-hazardous materials.
The feedstock is non-hazardous in itself. The resulting pyrolysis oil is pre-treated by Charm and tested to assure it complies with UIC regulations prior to its emplacement at Vaulted.

Feedstock Provider Organizations
Please provide a complete list of organizations involved in providing the feedstock, clarifying the organization's role and providing contact information for each. (*Please duplicate the below rows for each additional organization you wish to add)*
Organization 1
Company registration number (*Unique business identification number in your country of registration*): 1168427111
Organization Name: AE Cote-Nord Canada Bioenergy Inc.
Organization Address: 210-8000 Boulevard Langelier Sant-Leonard, QC H1P3K2 Canada
Contact Person:

Contact Email Address: pct.rh@arbec.co
[Optional] Contact Phone Number:
Organization role in project: Bio-Oil Vendor

Potential Market Leakage Impacts Eligibility	
Please select which of the Potential Market Leakage Impact Eligibility Criteria you're using to demonstrate eligibility for this feedstock.	
	EC1: Project Proponent does not pay for the feedstock
	EC2: Project Proponent receives a payment for the feedstock
	EC3: Project Proponent pays for recovery & replacement activities only
	EC4: Project Proponent pays to a 3rd party, not entity producing feedstock
x	EC5: Publicly managed forest management activity
	EC6: Certified forest management activity in increasing carbon stock areas
	EC7: Certified forest management activity in exceptional circumstances
	EC8: Sustainably sourced agricultural crop residue
	EC9: Surplus residue with no demonstrated growth of supply
Demonstrate how your feedstock meets it by providing the required documentation or analysis.	
Groupe Remabec, which is a parent company of AECN, harvests trees from publicly-owned forests in accordance with rights granted by the Province of Quebec under the Provincial Management Plan provided as supporting documentation for this Project. The harvest activity is also SFI-certified through the Bureau de Normalisation du Québec, a copy of the certificate is provided as additional documentation.	

Counterfactual Storage Eligibility
Please describe and attach any relevant evidence to demonstrate that your feedstock would have emitted the biogenic CO_2 to the atmosphere sooner than the required threshold period. If only a portion of your feedstock would have emitted the CO_2 after the threshold

period, attach relevant evidence and confirm that you have incorporated the relevant calculation into your LCA.
The Arbec sawmill, which provides AECN the sawdust and shavings used in pyrolysis, has a pile of sawmill residues that has been on site for years. The sawmill accumulated the pile of residues as a result of the shutdown of local businesses who had purchased it in the past. AECN was developed as a solution to this issue of residue accumulation. The historic fate of these residues absent AECN or other offtakers has been accumulation in this large pile. Pier and Kelly's study of waste sawdust in the Tennessee Valley (Pier and Kelly, 1997), included as documentation with this PDD, shows that anaerobic conditions in the center of such piles lead to significant methane production. In order to compute a conservative estimation of the counterfactual storage of piled sawdust, we assume that 1% of the biogenic carbon lost to decomposition is emitted as methane. In terms of the overall decomposition rate, studies of woody debris decay vary widely. However, Fasth et al. (2011) found an average of a 24% annual decay rate for smaller-sized particles in a study of 11 different tree species. This is confirmed by Blasdell's research on the decay rates of forest litter — This found a median 50% residence time of 2.48 years, from which a comparable decay rate can be inferred. Using this as a benchmark, the total CO2e released by decomposing wood within 15 years, from emission of CO2 and CH4, would exceed the total stored carbon of the wood. Additionally, at a 24% decay rate, after 50 years the piled woody material would have effectively decayed entirely. For this reason, we are assigning the sawmill residues used by AECN as a pyrolysis feedstock a counterfactual storage discount of 0. This calculation is in accordance with EC10 of the Biomass Feedstock Accounting module.

Dedicated Energy Feedstock Eligibility
This is only applicable to non-forestry feedstocks. *Please describe your analysis in how you determined that your feedstock isn't grown for the purposes of energy production.*
N/A

Counterfactual Fate of Feedstock
Please describe and attach any relevant evidence to demonstrate what the most likely counterfactual scenario would be for your feedstock, using guidance outlined in Section 3.2.1 of the Biomass Feedstock Module.

The bio-oil Charm sources from AECN is produced using sawdust and shavings generated by the Arbec lumber mill adjacent to AECN's pyrolysis facility. By purchasing the oil, Charm creates demand that AECN meets by offtaking additional residues from the mill. AECN's development was in large part triggered by the closure of other businesses in the region who had historically purchased these residues as a production input. Due to the remote location of the mill, the development of economically viable offtake relationships with businesses outside the region is a challenge. This is evidenced by Arbec and Groupe Remabec's decision to invest over $100 million CAD to start AECN and build out an onsite pyrolysis facility, as well as the accumulation of a large pile of sawdust as sawmill operations continued without a residue offtaker for a significant period of time. The AECN facility was the solution to this problem. Because its primary revenue stream is the production of wood boards for construction, the mill would have reason to continue to operate and create the residues currently used as pyrolysis feedstock by AECN if the pyrolysis facility were absent. Given the demonstrated difficulty of securing alternative offtake relationships, the historical fate of the feedstock in this scenario has been accumulation and piling on site.

Replacement Emissions	
Please select which method of replacement emissions accounting you've selected given the nature of your feedstock	
	Accounting for the feedstock replacement emissions in the LCA
X	Not accounting for replacement emissions due to exemption C1 *(Feedstock has no counterfactual use)*
	Not accounting for replacement emissions due to exemption C2 *(Feedstock counterfactual use is most likely replaced with a feedstock with no counterfactual use)*
	Not accounting for replacement emissions due to exemption C3 *(Feedstock has no counterfactual use due to surplus)*
If you selected an exemption above, please demonstrate how your feedstock meets it by providing the required documentation or analysis.	
See "Counterfactual Fate of Feedstock"	

Appendix 2: GHG Statement Report

Information requirements for verification are as follows:

- GHG Statement Report (this Appendix) containing information relating to the GHG Statement
- GHG Statement calculations (provided separately)
- Supporting information including copies of raw data used

An appropriate level of information should be provided with a clearly referenced and transparent audit trail of decision making, assumptions, explanations, such that a verifier can trace all inputs, outputs and decision making. All data sources and assumptions must be clearly referenced, transparent and traceable.

After this Appendix has been completed for the first time, it may be acceptable to refer back to relevant sections for subsequent Reporting Periods, for example if there have been no changes to the GHG Assessment scope, data collection methodology, calculation methodology or assumptions.

There is no word limit for answers in sections below.

General Information	
Name of practitioner who prepared the GHG Statement, and relevant competencies. This should include an overview of relevant qualifications and experience undertaking GHG assessments.	Max Lavine, Charm Industrial Operations
Date of report	2024/01/03
Please specify the Reporting Period this GHG Statement has been prepared for (the Reporting Period describes the time period over which the carbon removal activity assessed in the GHG Statement occurred)	At the time of this report, the initial injections associated with this project have not begun. It is anticipated that injections will occur in between now and the completion of project validation.
Relevant project information if not included in PDD	All data related to the calculation of removals will be transmitted from Charm's Ledger software to Isometric directly via API. What follows is an account of the data and calculations that will occur in Charm's Ledger software.
Details and links to any supporting documentation	The GHG Statement Supplemental Doc is appended to this PDD. The Doc shows the calculations for a "Sample Removal" in order to demonstrate calculation methodology and an estimation of the impact of the different

	emissions within the project boundary on overall removals.
Please confirm that the GHG Statement has been undertaken in accordance with the information provided in the project boundary section of this PDD. Provide any additional information relating to the GHG Statement project boundary here.	The GHG Statement has been undertaken in accordance with the information provided in the project boundary section of this PDD. All data collected relates to listed GHG Emissions Sources/Fluxes as identified in the main body of the document. There are a few exclusions from the Project Boundary that merit further explanation: **1. Salt used in bio-oil blending** a. The salt used in bio oil blending is off-spec salt from a nearby Morton's production facility. Because the salt is a waste product from an independently-occurring production process, we have not included the associated embodied emissions within the project boundary. **2. Injection Fuel Use** a. Vaulted has submitted their own PDD which has been validated by Isometric and a third-party verifier. It does not report any fuel use, therefore fuel use is not accounted for here. If that were to change, it would be reported in Vaulted's monthly energy consumption report and accounted for in a manner analogous to that documented in Fuel Use for Injectate Pre-Processing sections below

GHG Statement Methodology - Data
Provide information on the GHG Statement approach and methodology in relation to data collection. *This should include the following information as a minimum:* ● *Data collection procedures - how data was requested and gathered, who supplied each data point, the format data was received in, and the date data points were received* ● *How data quality was assessed and how the data hierarchy was followed in terms of using measured, calculated and estimated data. Evidence and justification should be*

provided in any cases where measured data was not used

- *Details of data validation processes followed, including treatment of missing data*

Evidence of all raw data that informed the assessment (including data that informed any assumptions) must be appended to the PDD, or linked within the GHG Statement.

Operational data and supporting documents will be transferred to Isometric via API. What is below is a summary of each data source and account of collection methods.

1. Fuel Use from Feedstock Transport
    a. Data Source: Vendor LCA
        i. The oil vendor (AECN) completed an LCA including the fuel used in feedstock transport using GHGenius Software
    b. Data Quality Assessment
        i. LCA is based on directly-measured data and calculations based on emissions factors
            1. Data for this LCA was collected in Spring/Summer of 2023. The expectation is that the vendor will update the LCA annually, or in light of major operational changes, whichever comes first
        ii. GHGenius software is a long-standing and well reputed LCA software whose data is primarily sourced from the Canadian government
        iii. Values are included in the bio oil Process Emissions and have been modified to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
2. Embodied Emissions from Feedstock Transport
    a. Data Sources: Vendor LCA, GREET, USEPA
        i. For all truck transport, the Vehicle Embodied Emissions are calculated using the GREET 2023 emissions factors for Medium-and-Heavy-Duty (MHDV) Trucks and Trailers. The total value for the embodied emissions is divided by the expected useful life for a Heavy Duty compression ignition (diesel) engine established by US EPA Office of Transportation and Air Quality in 2016 for engines manufactured after 2004 at 435,000 miles. This yields a quantity of embodied carbon per mile traveled.
            1. The trucks being used in this project are not used by Charm, but by AECN as part of their own operations. Therefore, only the mileage driven to transport biomass used for Charm bio oil is considered.
            2. Mileage is noted in the Vendor LCA (1.5km round trip)
            3. The emissions factor is modified to include the average "deadhead" or unloaded journey distance for a vehicle of this type according to USDA analysis
    b. Data Quality Assessment
        i. GREET, USDA, and the US EPA qualify as "reputable sources" given the Isometric Protocol's definition of "A source that would be widely considered trustworthy based on the process undertaken (e.g., peer review) or origin of the information (e.g., government body)."
        ii. The variable of mileage has a low uncertainty as it is a short trip between neighboring facilities

3. Fuel Use from Biomass Pyrolysis
    a. Fuel Use from Feedstock Transport
        i. Data Source: Vendor LCA
            1. The oil vendor (AECN) completed an LCA including the fuel used in feedstock transport using GHGenius Software
        ii. Data Quality Assessment
            1. LCA is based on directly-measured data and calculations based on emissions factors
                a. Data for this LCA was collected in Spring/Summer of 2023. The expectation is that the vendor will update the LCA annually, or in light of major operational changes, whichever comes first
            2. GHGenius software is a long-standing and well reputed LCA software whose data is primarily sourced from the Canadian government
            3. Values are included in the bio oil Process Emissions and have been modified to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
4. Electricity Use from Biomass Pyrolysis
    a. Fuel Use from Feedstock Transport
        i. Data Source: Vendor LCA
            1. The oil vendor (AECN) completed an LCA including the fuel used in feedstock transport using GHGenius Software
        ii. Data Quality Assessment
            1. LCA is based on directly-measured data and calculations based on emissions factors
                a. Data for this LCA was collected in Spring/Summer of 2023. The expectation is that the vendor will update the LCA annually, or in light of major operational changes, whichever comes first
            2. GHGenius software is a long-standing and well reputed LCA software whose data is primarily sourced from the Canadian government
            3. Values are included in the bio oil Process Emissions and have been modified to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
5. Stack Emissions from Pyrolysis Biomass Dryer
    a. Data Source
        i. The vendor has not analyzed stack emissions from their pyrolysis process. In absence of direct data, we were provided a modeling of process emissions from the technology in use (Ensyn RTP) processing woody biomass prepared for Natural Resources Canada detailing the addition of pyrolysis oil pathways to GHGenius software.
    b. Data Quality Assessment
        i. GHGenius software is a long-standing and well reputed LCA software whose data is primarily sourced from the Canadian government
        ii. Values are included in the bio oil Process Emissions and have been modified to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis

6. Embodied Emissions from Equipment and Facilities for Biomass Pyrolysis
    a. Data Sources
        i. Vendor has provided a total cost of facility build-out divided into construction, equipment, and installation costs
        ii. Emissions impact is calculated using NAICS Supply Chain Emissions Factors (cost-based) for Industrial Building Construction, Industrial Machinery Manufacturing, and Installation
    b. Data Quality Assessment
        i. The Vendor is the best available source for cost information on the build of their facility. The figure provided exceeds what has been described in the public record, ensuring a conservative estimate of impacts using a cost-based model
        ii. NAICS Supply Chain Greenhouse Gas Emissions Factors are provided by the US EPA which qualifies as a "reputable source" given the Isometric Protocol's definition
7. Fuel Use from Injectate Transport to Pre-Processing
    a. Trucking
        i. Data Sources
            1. Cargo is weighed using a calibrated truck scale when loaded by the vendor and documented with a Bill of Lading, scale ticket, and invoice document
            2. The vehicle routing is assessed using Google Maps, using the longest given route in order to ensure a conservative estimate of removals
            3. Vehicle Type is always a Heavy Duty Vehicle (tanker truck) due to the quantity and nature of cargo
            4. This information allows for the calculation of WTW emissions from fuel use using GLEC 3.0 emission factors
        ii. Data Quality Assessment
            1. Vehicle Type is always a Heavy Duty Vehicle (tanker truck) due to the quantity and nature of cargo
            2. Google Maps routing is a reliable source of mileage information and is controlled for uncertainty as described in the Uncertainty Analysis section
            3. Vendor scales are calibrated and the result is adjusted for the maximum allowable error for a calibrated legal-for-trade truck scale to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
            4. GLEC qualifies as a "reputable source" for emissions factors given the Isometric Protocol's definition
    b. Rail
        i. Data Sources
            1. Cargo is weighed using a calibrated truck scale when loaded by the vendor and documented with a Bill of Lading, scale ticket, and invoice document
            2. The vehicle routing is provided by the rail transport provider
            3. Vehicle Type is always a DOT-111 tanker truck, as this is the only type in Charm's rail fleet.
            4. This information allows for the calculation of WTW emissions

from fuel use using GLEC 3.0 emission factors

ii. Data Quality Assessment
1. Vehicle Type is always a DOT-111 tanker truck, as this is the only type in Charm's rail fleet.
2. The rail transport provider is a reliable source of mileage information
    a. The variable of mileage has a low uncertainty due to the number of alternative routes for rail transport being very limited relative to highway travel
3. Vendor scales are calibrated and the result is adjusted for the maximum allowable error for a calibrated legal-for-trade truck scale to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
4. GLEC qualifies as a "reputable source" for emissions factors given the Isometric Protocol's definition

8. Vehicle Embodied Emissions from Injectate Transport to Pre-Processing
    a. Truck
        i. Data Sources
            1. For all truck transport, the Vehicle Embodied Emissions are calculated using the GREET 2023 emissions factors for Medium-and-Heavy-Duty (MHDV) Trucks and Trailers. The total value for the embodied emissions is divided by the expected useful life in miles for a Heavy Duty compression ignition (diesel) engine established by US EPA Office of Transportation and Air Quality in 2016 for engines manufactured after 2004. This yields a quantity of embodied carbon per mile traveled.
                a. The trucks being used in this project are not used by Charm, but by a third-party transport provider contracted by Charm. Therefore, a method in which only the mileage driven while under contract is considered is necessary.
                b. The emissions factor is modified to include the average "deadhead" or unloaded journey distance for a vehicle of this type according to USDA analysis
        ii. Data Quality Assessment
            1. GREET, USDA, and the US EPA qualify as "reputable sources" given the Isometric Protocol's definition
            2. The variable of mileage has a low uncertainty, especially given that the routing between points is generally consistent over time and Google Maps route selection controls for uncertainty by selecting the longest route when multiple are presented to ensure a conservative estimate of removals
    b. Rail
        i. Data Sources
            1. For all rail transport, the Vehicle Embodied Emissions are calculated using the DOT average purchase cost of a DOT-111 railcar multiplied by the NAICS Supply Chain Emissions Factors (cost-based) for Railroad Rolling Stock. The total value

for the embodied emissions is divided by the expected useful life of DOT-111 rail cars in miles as assessed by Cambridge Systematics. This yields a quantity of embodied carbon per mile traveled

    a. The railcars being used in this project are leased to Charm but only used by Charm for a portion of their useful life. Therefore, a method in which only the mileage traveled while under lease is necessary.
    b. Vehicle routing is provided by the transport provider
    c. Journey distance is doubled to account for an unloaded round-trip because cars are leased to Charm specifically

2. Data Quality Assessment
    a. DOT, NAICS, and Cambridge Systematics qualify as "Reputable sources" given the Isometric protocol's definition
    b. The rail transport provider is a reliable source of mileage information
        i. The variable of mileage has a low uncertainty due to the number of alternative routes for rail transport being very limited relative to highway travel

9. Electricity Use from Injectate Pre-Processing
    a. Data Sources
        i. The pre-processing facility is not currently connected to grid power. Should that change, electricity use will be assessed using the onsite meter that measures overall electricity usage
        ii. The emissions impact of electricity generation will be determined using the US EPA eGrid emissions factor for the SPNO subregion, where the pre-processing site is located. To account for upstream emissions associated with generation infrastructure, a weighted average is calculated using the generation technology mix reported by EPA and the associated infrastructure emissions factors as determined by GREET. See KS Grid Emissions sheet in the GHG Statement doc included with this PDD.
    b. Data Quality Assessment
        i. Electricity use is measured using a calibrated instrument from the local utility provider calibrated and purpose-built for measuring power usage over time. Given that the readings are the basis for billing for power usage, the utility has a direct incentive to ensure their accuracy
        ii. Subregional grid emissions factors and generation technology mix are provided by the US EPA and grid infrastructure emissions factors from GREET, which are reputable sources under the Isometric Protocol's definition

10. Fuel Use from Injectate Pre-Processing
    a. Data Sources
        i. Diesel fuel for site operations is purchased on an ongoing basis – Invoices for fuel purchases are used to measure fuel usage on-site
        ii. Fuel quantity is multiplied by the emissions factor for diesel fuel combustion published in the most recent GLEC Framework (V3.0)

b. Data Quality Assessment
    i. Invoices provide an accurate representation of diesel purchases for the site, which constitute the sole source of fuel used. The result is adjusted for the maximum allowable error for a calibrated legal-for-trade fuel meter to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
    ii. As a source for emissions factors, GLEC is considered a "reputable source" under the Isometric Protocol's definition

11. Embodied Emissions from Equipment for Injectate Pre-Processing
    a. Data Sources
        i. Equipment Owned by Charm
            1. For equipment owned by Charm quantities of the primary site materials (concrete, stainless steel, steel, rubber, high-density polyethylene) are estimated by the site manager based on a master equipment list and expert judgment
            2. GREET emissions factors are used to calculate the emissions impact of quantified site materials
            3. Expected service life is estimated by internal engineering resources
        ii. Rented Equipment
            1. For rented equipment such as generators and material handling vehicles, the average market value is assessed using online marketplaces for these products
            2. Emissions impact is calculated using NAICS Supply Chain Emissions Factors (cost-based) for Diesel Generator and Construction Equipment Manufacturing
            3. Expected service life is estimated based on industry standards for the equipment type
    b. Data Quality Assessment
        i. While estimated values have a greater uncertainty than measured values, this estimate based on expert judgment is being used as is because it would have a less than 1% effect on net removal if increased by 20% as detailed in the Sensitivity Analysis in the GHG Statement supplemental doc
        ii. The expert judgment of the site manager effectively accounts for the approximate weight of Charm-owned equipment and the average use-time of rented machinery
        iii. As a source for emissions factors, GREET is considered a "reputable source" under the Isometric Protocol's definition
        iv. Online marketplaces provide a relatively reliable source of pricing data due to the high transaction volume and number of sellers on prominent sites for buying and selling equipment
        v. NAICS Supply Chain Greenhouse Gas Emissions Factors are provided by the US EPA which qualifies as a "reputable source" given the Isometric Protocol's definition
        vi. Industry standards provide a reasonable expectation regarding the overall service life of a common piece of equipment

12. Embodied Emissions from Consumables for Injectate Pre-Processing
    a. Data Sources

        i. Liquid Caustic Soda (50%) is added to bio oil in amounts measured by on-site staff using a flow meter
        ii. GREET emissions factors are used to calculate the emissions impact of LCS used
        iii. Salt is used as well, but it is a waste byproduct from a nearby Morton salt factory, so embodied emissions are not considered
    b. Data Quality Assessment
        i. The onsite flow meter provides a reliable measure of the quantity of LCS used. The result is adjusted for the uncertainty for a typical flow meter to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
        ii. As a source for emissions factors, GREET is considered a "reputable source" under the Isometric Protocol's definition

13. Fuel Use from Delivery of Consumables to Injectate Pre-Processing
    a. Data Sources
        i. Delivery invoices establish the mass of cargo transported to the Pre-Processing site and location of product origin, which is used to calculate the distance traveled
        ii. The vehicle routing is assessed using Google Maps, using the longest given route in order to ensure a conservative estimate of removals
        iii. Vehicle Type is always a Heavy Duty Vehicle (flatbed truck) due to the quantity and nature of cargo
        iv. This information allows for the calculation of WTW emissions from fuel use using GLEC 3.0 emission factors
    b. Data Quality Assessment
        i. Because delivery invoices are the basis for billing for goods delivered, vendors have a direct incentive to ensure their accuracy
        ii. Vehicle Type is always a Heavy Duty Vehicle (flatbed truck) due to the quantity and nature of cargo
        iii. Google Maps routing is a reliable source of mileage information and is controlled for uncertainty as described above
        iv. GLEC qualifies as a "reputable source" for emissions factors given the Isometric Protocol's definition

14. Embodied Emissions from Delivery of Consumables to Injectate Pre-Processing
    a. Data Sources
        i. For all truck transport, the Vehicle Embodied Emissions are calculated using the GREET 2023 emissions factors for Medium-and-Heavy-Duty (MHDV) Trucks and Trailers. The total value for the embodied emissions is divided by the expected useful life for a Heavy Duty compression ignition (diesel) engine established by US EPA Office of Transportation and Air Quality in 2016 for engines manufactured after 2004 at 435,000 miles. This yields a quantity of embodied carbon per mile traveled.
            1. The trucks being used in this project are not used by Charm, but by a third-party transport provider contracted by Charm. Therefore, only the mileage driven while under contract is considered.
            2. The emissions factor is modified to include the average "deadhead" or unloaded journey distance for a vehicle of this

type according to USDA analysis

b. Data Quality Assessment
    i. GREET, USDA, and the US EPA qualify as "reputable sources" given the Isometric Protocol's definition
    ii. The variable of mileage has a low uncertainty, especially given that the routing between points is generally consistent over time and Google Maps route selection controls for uncertainty by selecting the longest route when multiple are presented to ensure a conservative estimate of removals

15. Fuel Use from Processed Injectate Transport to Injection Site
    a. Data Sources
        i. Cargo is weighed using a calibrated truck scale at the injection site and documented with a weigh scale ticket
        ii. The vehicle routing is assessed using Google Maps, using the longest given route in order to ensure a conservative estimate of removals
        iii. Vehicle Type is always a Heavy Duty Vehicle (tanker truck) due to the quantity and nature of cargo
        iv. This information allows for the calculation of WTW emissions from fuel use using GLEC 3.0 emission factors
    b. Data Quality Assessment
        i. Vehicle Type is always a Heavy Duty Vehicle (tanker truck) due to the quantity and nature of cargo
        ii. Google Maps routing is a reliable source of mileage information and is controlled for uncertainty as described above
        iii. Injection site scales are calibrated and the result is adjusted for the maximum allowable error for a calibrated legal-for-trade truck scale to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
        iv. GLEC qualifies as a "reputable source" for emissions factors given the Isometric Protocol's definition

16. Vehicle Embodied Emissions for Processed Injectate Transport to Injection Site
    a. Data Sources
        i. For all truck transport, the Vehicle Embodied Emissions are calculated using the GREET 2023 emissions factors for Medium-and-Heavy-Duty (MHDV) Trucks and Trailers. The total value for the embodied emissions is divided by the expected useful life for a Heavy Duty compression ignition (diesel) engine established by US EPA Office of Transportation and Air Quality in 2016 for engines manufactured after 2004 at 435,000 miles. This yields a quantity of embodied carbon per mile traveled.
            1. The trucks being used in this project are not used by Charm, but by a third-party transport provider contracted by Charm. Therefore, only the mileage driven while under contract is considered.
            2. The emissions factor is modified to include the average "deadhead" or unloaded journey distance for a vehicle of this type according to USDA analysis
    b. Data Quality Assessment
        i. GREET, USDA, and the US EPA qualify as "reputable sources" given

the Isometric Protocol's definition

ii. The variable of mileage has a low uncertainty, especially given that the routing between points is generally consistent over time and Google Maps route selection controls for uncertainty by selecting the longest route when multiple are presented to ensure a conservative estimate of removals

17. Final Injectate Mass
    a. Data Sources
        i. Delivered injectate will be weighed using the Well Operator's on-site truck scale by taking the weight of the delivery vehicle prior to and following offloading the injectate as specified in the written agreement between Charm and the Well Operator contracting emplacement services. Weigh scale tickets are produced for each load to document the mass injected
    b. Data Quality Assessment
        i. Well Operator scales are calibrated and the result is adjusted for the maximum allowable error for a calibrated legal-for-trade truck scale to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
18. Electricity Use from Injection
    a. Data Sources
        i. Agreement between the Charm and Well Operator specifies that the Well Operator will provide monthly reports of the energy consumption on site, including electricity as metered by the local utility, as a reflection of the total hours of operations during services provided to Charm
            1. The emissions impact of electricity generation will be determined using the US EPA eGrid emissions factor for the SPNO subregion, where the pre-processing site is located. To account for upstream emissions associated with generation infrastructure, a weighted average is calculated using the generation technology mix reported by EPA and the associated infrastructure emissions factors as determined by GREET. This is covered in the GHG Statement Supplementary Doc included with this PDD.
    b. Data Quality Assessment
        i. Electricity use is measured using a calibrated instrument from the local utility provider calibrated and purpose-built for measuring power usage over time. Given that the readings are the basis for billing for power usage, the utility has a direct incentive to ensure their accuracy
        ii. Subregional grid emissions factors and generation technology mix are provided by the US EPA and grid infrastructure emissions factors, which are reputable sources under the Isometric Protocol's definition
19. Embodied Emissions from Injection Equipment
    a. Data Sources
        i. In the GHG Statement provided as part of their own PDD, Vaulted calculated that their onsite equipment accounts for 0.0000351566 tons of steel and 0.000077 m3 of concrete per ton of waste injected, given their conservative estimate of a 2 million metric ton overall well

capacity.

ii. The embodied emissions impact of these material quantities per ton of injectant are calculated using the GREET emissions factors for these materials

b. Data Quality Assessment

i. Vaulted's calculation of on-site materials was validated and verified under the Isometric protocol and is therefore considered a reliable source of data

ii. Both GREET qualifies as a "reputable source" for emissions factors given the Isometric Protocol's definition

20. Carbon Content of Injected Bio Oil

a. Data Sources

i. Mass of Injectate will be determined by using an on-site truck scale that will be used to weigh the delivery truck prior to and after injection. A weigh station ticket will be produced to verify mass injected

ii. Mass of Injected Bio Oil will be determined by subtracting the mass of salt and LCS used for a particular batch of injectate from the Mass of Injectate

iii. Carbon content of the oil will be measured using Isometric Protocol Method A – Each injection batch will be sampled prior to the addition of salt and LCS and samples will be sent to an analytic lab to measure the carbon content of that batch. 3 samples are taken, and the average of the 3 results is the value for C content associated with the injection batch

b. Data Quality Assessment

i. The scale used at Vaulted's on-site weigh station is properly calibrated and maintained by Vaulted and the result is adjusted for the maximum allowable error for a calibrated legal-for-trade truck scale to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis

ii. All additions to the injectate are monitored using an on-site scale (solid additions) and flow meter (liquid additions) for each batch

iii. Carbon content is measured by analytic testing at an ISO-certified lab and based directly on the batch being injected. The result is adjusted for the maximum allowable error for lab analysis to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis

21. Emissions from Sample Transport to Lab

a. Data Sources

i. The number of tests, samples, and sample weights are internally standardized for each injection batch and calculated as reported by the Charm Chemistry and Research teams

ii. Distance between the sampling site and labs is determined according to Google Maps routing. Road distances are used despite the transport assumption being air freight. This is due to the fact that road distances will reliably be longer than the more direct route allowed by air travel, ensuring a conservative estimate of removals

iii. This information allows Charm to calculate the Well to Wheel (WTW) emissions associated with air transport using emissions factors from the GLEC Framework

b. Data Quality Assessment
    i. Data on the number of tests and location of testing labs comes directly from the team responsible for managing this function.
    ii. The variable of mileage has a low uncertainty, especially given that the routing between points is generally consistent over time and Google Maps route selection controls for uncertainty by selecting the longest route when multiple are presented and using road directions to ensure a conservative estimate of removals

GHG Statement Methodology - Calculations
Provide information on the GHG Statement approach and methodology in relation to calculations. *This should include the following information as a minimum:* ● *General description of the methodology, criteria and procedures used as a basis for the assessment, including reference to any documentation (including Isometric protocols and modules), guidance, industry standards and best practice that were followed* ● *Information on calculation procedures followed* ● *Information on any tools used as part of the assessment* ● *Procedure for selecting emission factors including how age (age of data, and the period over which they have been collected), geography (the region or country from where the data have originated), technology (whether the data are specific to a particular technology or mix of many), methodology (the approach applied to gather or calculate the data) and competency (proficiency of entity that developed the data) were considered.* ● *Assumptions and limitations - provide full transparency in terms of value-choices, rationales and expert judgements* ● *Details of a sensitivity analysis, how parameters were assessed and evidence behind choices* ● *Details of uncertainty analysis* ● *Details of any uncertainty adjustments (e.g. %) applied in instances of high uncertainty*
All calculations will be executed in the Ledger, a software tool developed in-house at Charm to track removals and calculate Net CDR. What follows is a description of the workflows that will be executed in the Ledger. Ledger Data will be shared with Isometric via API. 22. Fuel Use from Feedstock Transport a. Calculation methodology i. Value in Vendor LCA is applied as a constant deduction against each ton of bio oil purchased b. Justification of Variables and Emissions factors used i. Vendor has provided an LCA compiled using GHGenius software ii. Charm must rely on vendor inputs in order to account for the LCA associated with vendor production activities 1. Data for this LCA was collected in Spring/Summer of 2023. The expectation is that the vendor will update the LCA annually, or

in light of major operational changes, whichever comes first

   iii. GHGenius software is a long-standing and well reputed LCA software whose data is primarily sourced from the Canadian government
   iv. Values related to process emissions have been modified to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis

c. Unit/Frequency of Calculation
   i. This will be applied as a static value against each MT of bio-oil delivered

d. Modifications to Address Uncertainty
   i. This value is part of the overall "Process Emissions" for the purchased bio oil. Process Emissions are treated as an emissions factor. An Uncertainty Factor has been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details regarding the Uncertainty Factor can be found in the Uncertainty Assessment section here and in the GHG Statement Supplemental Doc

23. Embodied Emissions from Feedstock Transport
   a. Calculation Methodology
      i. Per-mile embodied emissions are calculated based on GREET emissions levels for the manufacture of medium-and-heavy-duty trucks and trailers and divided by EPA expected useful life in mileage for heavy-duty diesel engines. This calculation yields a per-mile embodied emissions level that can be applied to Charm-specific journeys using vehicles owned by the vendor
      ii. Per-mile embodied emissions are applied to the oil being transported according to journey distance
   b. Justification of Variables and Emissions factors used
      i. GREET, USDA, and the US EPA qualify as "reputable sources" given the Isometric Protocol's definition of "A source that would be widely considered trustworthy based on the process undertaken (e.g., peer review) or origin of the information (e.g., government body)."
      ii. The variable of mileage has a low uncertainty as it is a short trip between neighboring facilities
   c. Unit/Frequency of Calculation
      i. This will be applied as a static value against each MT of bio-oil delivered
   d. Modifications to Address Uncertainty
      i. This value is part of the overall "Embodied Emissions" for the purchased bio oil. This value is being used as is due to demonstrating a less than 1% change in the Net Removal in the Sensitivity Analysis. See the "Sensitivity Analysis" sheet in the supplemental GHG Statement doc

24. Fuel Use from Biomass Pyrolysis
   a. Calculation methodology
      i. Value in Vendor LCA is applied as a constant deduction against each ton of bio oil purchased
   b. Justification of Variables and Emissions factors used
      i. Vendor has provided an LCA compiled using GHGenius software

        ii. Charm must rely on vendor inputs in order to account for the LCA associated with vendor production activities
            1. Data for this LCA was collected in Spring/Summer of 2023. The expectation is that the vendor will update the LCA annually, or in light of major operational changes, whichever comes first
        iii. GHGenius software is a long-standing and well reputed LCA software whose data is primarily sourced from the Canadian government
        iv. Values related to process emissions have been modified with an Uncertainty Factor to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
    c. Unit/Frequency of Calculation
        i. This will be applied as a static value against each MT of bio-oil delivered
    d. Modifications to Address Uncertainty
        i. This value is part of the overall "Process Emissions" for the purchased bio oil. Process Emissions are treated as an emissions factor. An Uncertainty Factor has been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details regarding the Uncertainty Factor can be found in the Uncertainty Assessment section here and in the GHG Statement supplemental doc

25. Electricity Use from Biomass Pyrolysis
    a. Calculation methodology
        i. Value in Vendor LCA is applied as a constant deduction against each ton of bio oil purchased
    b. Justification of Variables and Emissions factors used
        i. Vendor has provided an LCA compiled using GHGenius software
        ii. Charm must rely on vendor inputs in order to account for the LCA associated with vendor production activities
            1. Data for this LCA was collected in Spring/Summer of 2023. The expectation is that the vendor will update the LCA annually, or in light of major operational changes, whichever comes first
        iii. GHGenius software is a long-standing and well reputed LCA software whose data is primarily sourced from the Canadian government
        iv. Values related to process emissions have been modified with an Uncertainty Factor to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
    c. Unit/Frequency of Calculation
        i. This will be applied as a static value against each MT of bio-oil delivered
    d. Modifications to Address Uncertainty
        i. This value is part of the overall "Process Emissions" for the purchased bio oil. Process Emissions are treated as an emissions factor. An Uncertainty Factor has been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details regarding the Uncertainty Factor can be found in the Uncertainty Assessment section here and in the GHG Statement supplemental doc

26. Stack Emissions from Biomass Pyrolysis

a. Calculation Methodology
    i. The vendor has not performed an analysis of stack emissions arising from their pyrolysis process
    ii. In lieu of a direct analysis, the vendor provided an analysis of the specific technology in use prepared for Natural Resources Canada detailing the addition of the technology to the GHGenius software used for their process LCA
    iii. The values for Greenhouse Gases were converted from emissions per GJ of feedstock to emissions per MT of oil based on the input and output data from the Vendor LCA and added to the overall process emissions associated with their pyrolysis process
b. Justification of Variables and Emissions Factors Used
    i. The object of the analysis provided is the specific technology and feedstock used to produce the bio oil used for this project
    ii. Charm must rely on vendor inputs in order to account for the LCA associated with vendor production activities
    iii. GHGenius software is a long-standing and well reputed LCA software whose data is primarily sourced from the Canadian government
    iv. Values related to process emissions have been modified with an Uncertainty Factor to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
c. Unit/Frequency of Calculation
    i. This will be applied as a static value against each MT of bio-oil delivered
d. Modifications to Address Uncertainty
    i. This value is part of the overall "Process Emissions" for the purchased bio oil. Process Emissions are treated as an emissions factor. An Uncertainty Factor has been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details regarding the Uncertainty Factor can be found in the Uncertainty Assessment section here and in the GHG Statement supplemental doc

27. Embodied Emissions from Equipment and Facilities for Biomass Pyrolysis
    a. Calculation Methodology
        i. The bio oil vendor has not performed an evaluation of the embodied emissions associated with the construction of their building or manufacture of their equipment. Therefore, the best option available to Charm for determining these impacts is to use a cost-based calculation. This is achieved by applying per-dollar-spent supply chain emissions factors to the cost of construction, equipment, and installation and dividing that total by the expected lifetime production of the facility to arrive at a quantity of CO2e per MT of oil produced associated with facility embodied emissions.
    b. Justification of Variables and Emissions factors used
        i. The Vendor is the best available source for cost information on the build of their facility. The figure provided exceeds what has been described in the public record, ensuring a conservative estimate of impacts using a cost-based model
        ii. NAICS Supply Chain Greenhouse Gas Emissions Factors are provided

by the US EPA which qualifies as a "reputable source" given the Isometric Protocol's definition

c. Unit/Frequency of Calculation
    i. This will be applied as a static value against each MT of bio-oil delivered

d. Modifications to Address Uncertainty
    i. This value is part of the overall "Embodied Emissions" for the purchased bio oil. This value is being used as is due to demonstrating a less than 1% change in the Net Removal in the Sensitivity Analysis. See the "Sensitivity Analysis" sheet in the supplemental GHG Statement doc

28. Fuel Use from Injectate Transport to Pre-Processing
    a. Truck
        i. Calculation Methodology
            1. Cargo weight according to Vendor-provided Bill of Lading, scale ticket and invoice docs and point-to-point distance from Google Maps are used to calculate the WTW emissions for the journey using a Tanker Truck by applying the appropriate GLEC V3.0 emissions factor (tanker truck) to the tons-miles value
        ii. Justification of Variables and Emissions Factors Used
            1. Vehicle Type is always a Heavy Duty Vehicle (tanker truck) due to the quantity and nature of cargo
            2. Google Maps routing is a reliable source of mileage information and is controlled for uncertainty as described in the Uncertainty Analysis section
            3. Vendor scales are calibrated and the result is adjusted for the maximum allowable uncertainty for a calibrated legal-for-trade truck scale to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
            4. GLEC qualifies as a "reputable source" for emissions factors given the Isometric Protocol's definition
        iii. Unit/Frequency of Calculation
            1. Transport emissions are calculated and assigned to each truckload of bio oil loaded into Transport Provider vehicles for delivery by vendor
            2. Ledger software associates these values with the oil as it is divided and recombined for transport and processing until its final form as an injection batch
        iv. Modifications to Address Uncertainty
            1. Uncertainty considerations have been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details can be found in the Uncertainty Assessment section here and in the GHG Statement supplemental doc
    b. Rail
        i. Calculation Methodology
            1. Cargo weight according to Vendor-provided Bill of Lading, scale ticket and invoice docs and point-to-point distance the rail provider are used to calculate the WTW emissions for the

journey using the GLEC V3.0 US rail emissions factor

ii. Justification of Variables and Emissions Factors Used
    1. GLEC provides a single unified emissions factor for North American rail transport
    2. The rail transport provider is a reliable source of mileage information
        a. The variable of mileage has a low uncertainty due to the number of alternative routes for rail transport being very limited relative to highway travel
    3. Vendor scales are calibrated and the result is adjusted for the maximum allowable error for a calibrated legal-for-trade truck scale to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
    4. GLEC qualifies as a "reputable source" for emissions factors given the Isometric Protocol's definition

iii. Unit/Frequency of Calculation
    1. Transport emissions are calculated and assigned to each railcar of bio oil loaded into Charm-leased railcars for delivery by vendor
    2. Ledger software associates these values with the oil as it is divided and recombined for transport and processing until its final form as an injection batch

iv. Modifications to Address Uncertainty
    1. Uncertainty considerations have been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details can be found in the Uncertainty Assessment section here and in the GHG Statement supplemental doc

29. Vehicle Embodied Emissions from Injectate Transport to Pre-Processing
    a. Truck
        i. Calculation Methodology
            1. Per-mile embodied emissions are calculated based on GREET emissions levels for the manufacture of medium-and-heavy-duty trucks and trailers and divided by EPA expected useful life in mileage for heavy-duty diesel engines. This calculation yields a per-mile embodied emissions level that can be applied to Charm-specific journeys using vehicles owned by a transport contractor.
            2. The emissions factor is modified to include the average "deadhead" or unloaded journey distance for a vehicle of this type according to USDA analysis
            3. Per-mile embodied emissions are applied to the oil being transported according to journey distance.
        ii. Justification of Variables and Emissions factors used
            1. GREET, USDA, and the US EPA qualify as "reputable sources" given the Isometric Protocol's definition of "A source that would be widely considered trustworthy based on the process undertaken (e.g., peer review) or origin of the information (e.g., government body)."

2. Google Maps routing is a reliable source of mileage information and is controlled for uncertainty as described in the Uncertainty Analysis section
3. Calculation of embodied emissions by mile is necessary due to the fact that the trucks may be used by the transport provider for different routes and applications over time. Therefore, a calculation method is appropriate that only takes into account the mileage associated with Charm journeys.

iii. Unit/Frequency of Calculation
1. Transport emissions are calculated and assigned to each truckload of bio oil loaded into Transport Provider vehicles for delivery by vendor
2. Ledger software associates these values with the oil as it is divided and recombined for transport and processing until its final form as an injection batch

iv. Modifications to Address Uncertainty
1. This value is being used as is due to demonstrating a less than 1% change in the Net Removal in the Sensitivity Analysis. See the "Sensitivity Analysis" sheet in the supplemental GHG Statement doc

b. Rail

i. Calculation Methodology
1. Per-mile embodied emissions are calculated based on DOT's reported average purchase cost of a DOT-111 tank car, which is the type used by Charm for bio oil transport. This cost is multiplied by the NAICS Supply Chain Emissions Factor (cost-based) for the manufacture of railroad rolling stock.
2. Per-mile embodied emissions are applied to the oil being transported according to journey distance. Emissions associated with transport once the vehicle is empty are calculated based on the assumption of a round trip due to the cars only being used for Charm bio oil transport while under lease by Charm

ii. Justification of Variables and Emissions factors used
1. Both DOT and the NAICS qualify as "reputable sources" given the Isometric Protocol's definition of "A source that would be widely considered trustworthy based on the process undertaken (e.g., peer review) or origin of the information (e.g., government body)."
   a. GREET emissions data for the manufacture of railcars is not available. The most expedient, reliably sourced data to calculate embodied emissions was cost-based, sourced from DOT and NAICS
2. Calculation of embodied emissions by mile is necessary due to the fact that the railcars are only leased by Charm for a portion of their useful life. Therefore, journey mileage is the most representative way to quantify the portion of that life associated with Charm's use.

iii. Unit/Frequency of Calculation
1. Transport emissions are calculated by mile and assigned to each

truckload of bio oil loaded into Charm railcars for delivery by vendor

2. Ledger software associates these values with the oil as it is divided and recombined for transport and processing until its final form as an injection batch

iv. Modifications to Address Uncertainty

1. This value is being used as is due to demonstrating a less than 1% change in the Net Removal in the Sensitivity Analysis. See the "Sensitivity Analysis" sheet in the supplemental GHG Statement doc

30. Electricity Use from Injectate Pre-Processing

a. Calculation Methodology

i. The pre-processing facility is not currently connected to grid power. Should that change, electricity use will be assessed using the onsite meter that measures overall electricity usage

ii. Electricity emissions are calculated by kWh usage multiplied by the per kWh emissions for the SPP North grid subregion as reported by the EPA eGrid emissions factors. This is supplemented by a per-kWh addition to account for the embodied emissions associated with grid infrastructure as quantified by a weighted average of power generation sources based on the fuel mix for the subregion reported by the EPA and the applicable electricity infrastructure emissions factors reported by GREET

b. Justification of Variables and Emissions Factors Used

i. Electricity use is measured using a calibrated instrument from the local utility provider calibrated and purpose-built for measuring power usage over time. Given that the readings are the basis for billing for power usage, the utility has a direct incentive to ensure their accuracy

ii. Subregional grid emissions factors and generation technology mix are provided by the US EPA and grid infrastructure emissions factors from GREET, which are reputable sources under the Isometric Protocol's definition

c. Unit/Frequency of Calculation

i. Electricity use is treated as a "site emission"

1. Metered use rates are reported monthly by site staff
2. Reported use-rates are multiplied by listed emissions factors to calculate emissions impact of usage
3. Calculated impact is deducted from net CDR for oil processed on site

d. Modifications to Address Uncertainty

i. N/A, site is not on grid power

31. Fuel Use from Injectate Pre-Processing

a. Calculation Methodology

i. Emissions impact of fuel usage is calculated based on GLEC models for fuel combustion in terms of TCO2e/kg fuel multiplied by the quantity of fuel purchased for use on site as documented by purchase invoices. This quantity is corrected for fuel pump uncertainty as detailed in the Uncertainty Analysis

b. Justification of Variables and Emissions Factors Used

i. All fuel used on site will be purchased and an invoice will be issued to record that purchase which is reflective of the amount dispensed by a gas meter. Because the meter is used to determine billing, the fuel vendor has a direct financial incentive to ensure that it is accurate.

ii. GLEC V3.0 is a reputable source for emissions factors according to the definition provided in the Isometric Protocol and is the most recent version of the framework

c. Unit/Frequency of Calculation

i. Fuel use is treated as a "site emission"

1. Invoiced use rates are reported monthly by site staff
2. Reported use-rates are multiplied by listed emissions factors to calculate emissions impact of usage
3. Calculated impact is deducted from net CDR for oil processed on site

d. Modifications to Address Uncertainty

i. Uncertainty considerations have been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details regarding these considerations can be found in the Uncertainty Assessment section here and in the GHG Statement supplemental doc

32. Embodied Emissions from Equipment for Injectate Pre-Processing

a. Calculation Methodology

i. Charm-Owned Equipment

1. Material weights for on-site equipment owned by Charm are estimated by the site manager based on a site equipment list and expert judgment.
2. Weights are multiplied by the appropriate GREET emissions factor for the corresponding material and the CO2e calculated is divided by the expected useful life of the equipment in order to compute a straight-line amortization rate deducted from removals associated with the site during each reporting period over the equipment's useful life.

ii. Rented Equipment

1. The embodied emissions associated with rented machinery are computed using a cost-based calculation in which a per-dollar-spent supply chain emissions factor is applied to the average market value for the equipment.
2. This value is divided by the expected useful life of the machinery (measured in hours) and multiplied by the average number of hours of weekly service as estimated by the site manager. This value is deducted from removals associated with the site during each reporting period in which the equipment is in service.

iii. See "El Dorado Parts List + Estimated Material Weights" and "El Dorado Embodied Emissions Calc Sheet" sheets in GHG Statement supplemental document

b. Justification of Variables and Emissions Factors Used

i. Weight estimates are based on expert judgment bounded by a list of the specific components on site

ii. Average weekly service hours for rented machinery are based on expert judgment based on direct operational experience

iii. The majority of Charm-owned on-site equipment is composed of a single, identifiable primary material – E.g. Stainless steel blending tanks, concrete pad, rebar, and pump equipment. Therefore, a calculation based on the weight of primary materials is appropriate.

iv. Rented machinery is more complex, including diesel generators, a thermal oxidizer, and construction vehicles. Because this equipment is composed of a variety of material types and has a publicly-available market value and useful life estimate a cost-based calculation is appropriate.

v. GREET 2023 and NAICS are reputable sources for emissions factors according to the definition provided in the Isometric Protocol and is the most recent version of the framework

c. Unit/Frequency of Calculation

i. Embodied emissions of equipment are calculated and automatically amortized over the expected useful life of the equipment and deducted from net CDR associated with removals processed at the facility during each reporting period based on time elapsed

d. Modifications to Address Uncertainty

i. This value is being used as is due to demonstrating a less than 1% change in the Net Removal in the Sensitivity Analysis. See the "Sensitivity Analysis" sheet in the supplemental GHG Statement doc

33. Embodied Emissions from Consumables for Injectate Pre-Processing

a. Calculation Methodology

i. Liquid Caustic Soda (50%) is added to bio oil at a rate measured by a flow meter and recorded by on-site staff

ii. Quantity of LCS add is multiplied by the GREET emissions factor for LCS in order to calculate embodied emissions

iii. Salt added to the bio oil is a waste product and is not included in the calculation.

b. Justification of Variables and Emissions Factors Used

i. Volume measured by a flow meter provides an acceptably accurate measurement of the volume of LCS. Standardized markings on the container to measure volume provide an additional check. The result is adjusted for the typical uncertainty for a flow meter to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis

ii. GREET 2023 is a reputable source for emissions factors according to the definition provided in the Isometric Protocol and is the most recent version of the framework

c. Unit/Frequency of Calculation

i. Embodied emissions of LCS are deducted from net CDR for each MT of oil processed

d. Modifications to Address Uncertainty

i. Uncertainty considerations have been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details regarding the Uncertainty Factor can be found in the Uncertainty Assessment section here and in the GHG Statement supplemental doc

34. Fuel Use from Consumables Transport to Pre-Processing Site
    a. Calculation Methodology
        i. Cargo weight according to Vendor-provided Bill of Lading and point-to-point distance from Google Maps are used to calculate the WTW emissions for the journey using a flat-bed truck by applying the appropriate GLEC V3.0 emissions factor (flat-bed truck) to the tons-miles value
    b. Justification of Variables and Emissions Factors Used
        i. Vehicle Type is always a Heavy Duty Vehicle (flat-bed truck) due to the quantity and nature of cargo
        ii. Google Maps routing is a reliable source of mileage information and is controlled for uncertainty as described in the Uncertainty Analysis section
        iii. Vendor scales are calibrated and the result is adjusted for the maximum allowable error for a calibrated legal-for-trade truck scale to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
        iv. GLEC qualifies as a "reputable source" for emissions factors given the Isometric Protocol's definition
    c. Unit/Frequency of Calculation
        i. Transport emissions are calculated and assigned to each delivery of consumables to the pre-processing site
        ii. Delivery transport emissions are treated as a "site emission"
            1. Delivery source and weight are recorded by site staff for each delivery
            2. Reported deliveries are multiplied by listed emissions factors to calculate emissions impact of deliveries
            3. Calculated impact is deducted from net CDR for oil processed on site
    d. Modifications to Address Uncertainty
        i. Uncertainty considerations have been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details regarding the Uncertainty Factor can be found in the Uncertainty Assessment section here and in the GHG Statement supplemental doc
35. Embodied Emissions from Consumables Transport to Pre-Processing Site
    a. Calculation Methodology
        i. Per-mile embodied emissions are calculated based on GREET emissions levels for the manufacture of medium-and-heavy-duty trucks and trailers and divided by EPA expected useful life in mileage for heavy-duty diesel engines. This calculation yields a per-mile embodied emissions level that can be applied to Charm-specific journeys using vehicles owned by a vendor.
        ii. Actual journey distance is extended by the average proportion of "deadhead" or unloaded miles traveled by a vehicle of this type as reported by the USDA analysis of the trucking industry
        iii. Per-mile embodied emissions are applied to the product being transported according to journey distance.
    b. Justification of Variables and Emissions factors used

        i. GREET, USDA, and the US EPA qualify as "reputable sources" given the Isometric Protocol's definition.
        ii. Google Maps routing is a reliable source of mileage information and is controlled for uncertainty as described in the Uncertainty Analysis section
        iii. Calculation of embodied emissions by mile is necessary due to the fact that the trucks may be used by the transport provider for different routes and applications over time. Therefore, a calculation method is appropriate that only takes into account the mileage associated with Charm journeys.
    c. Unit/Frequency of Calculation
        i. Transport emissions are calculated and assigned to each delivery of consumables to the pre-processing site
        ii. Delivery transport emissions are treated as a "site emission"
            1. Delivery source and weight are recorded by site staff for each delivery
            2. Reported deliveries are multiplied by listed emissions factors to calculate emissions impact of deliveries
            3. Calculated impact is deducted from net CDR for oil processed on site
    d. Modifications to Address Uncertainty
        i. This value is being used as is due to demonstrating a less than 1% change in the Net Removal in the Sensitivity Analysis. See the "Sensitivity Analysis" sheet in the supplemental GHG Statement doc

36. Fuel Use from Processed Injectate Transport to Injection Site
    a. Calculation Methodology
        i. Cargo weight according to Vendor-provided Bill of Lading and point-to-point distance from Google Maps are used to calculate the WTW emissions for the journey using a Tanker Truck by applying the appropriate GLEC V3.0 emissions factor (tanker truck) to the tons-miles value
    b. Justification of Variables and Emissions Factors Used
        i. Vehicle Type is always a Heavy Duty Vehicle (tanker truck) due to the quantity and nature of cargo
        ii. Google Maps routing is a reliable source of mileage information and is controlled for uncertainty as described in the Uncertainty Analysis section
        iii. Well Operator scales are calibrated and the result is adjusted for the maximum allowable error for a calibrated legal-for-trade truck scale to ensure a conservative estimate of removals as detailed in the Uncertainty Analysis
        iv. GLEC qualifies as a "reputable source" for emissions factors given the Isometric Protocol's definition
    c. Unit/Frequency of Calculation
        i. Transport emissions are calculated and assigned to each truckload of bio oil delivered to the injection site
        ii. Ledger software associates these values with the specific injection batch and deducts them from net CDR
    d. Modifications to Address Uncertainty

i. Uncertainty considerations have been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details regarding the Uncertainty Factor can be found in the Uncertainty Assessment section here and in the GHG Statement supplemental doc

37. Vehicle Embodied Emissions for Processed Injectate Transport to Injection Site
   a. Calculation Methodology
      i. Per-mile embodied emissions are calculated based on GREET emissions levels for the manufacture of medium-and-heavy-duty trucks and trailers and divided by EPA expected useful life in mileage for heavy-duty diesel engines. This calculation yields a per-mile embodied emissions level that can be applied to Charm-specific journeys using vehicles owned by a transport contractor.
      ii. Per-mile embodied emissions are applied to the oil being transported according to journey distance
      iii. Actual journey distance is extended by the average proportion of “deadhead” or unloaded miles traveled by a vehicle of this type as reported by the USDA analysis of the trucking industry
   b. Justification of Variables and Emissions factors used
      i. GREET, USDA, and the US EPA qualify as “reputable sources” given the Isometric Protocol’s definition.
      ii. Google Maps routing is a reliable source of mileage information and is controlled for uncertainty as described in the Uncertainty Analysis section
      iii. Calculation of embodied emissions by mile is necessary due to the fact that the trucks may be used by the transport provider for different routes and applications over time. Therefore, a calculation method is appropriate that only takes into account the mileage associated with Charm journeys.
   c. Unit/Frequency of Calculation
      i. Transport emissions are calculated and assigned to each truckload of bio oil loaded into Transport Provider vehicles for delivery by vendor
      ii. Ledger software associates these values with the oil as it is divided and recombined for transport and processing until its final form as an injection batch
   d. Modifications to Address Uncertainty
      i. This value is being used as is due to demonstrating a less than 1% change in the Net Removal in the Sensitivity Analysis. See the “Sensitivity Analysis” sheet in the supplemental GHG Statement doc

38. Final Injectate Mass
   a. Calculation Methodology
      i. Injectate Mass for each injection batch is determined by weigh scale tickets produced by the calibrated truck scale at the Well Operator site
   b. Justification of Variables and Emissions Factors Used
      i. The directly-measured mass of the injectate delivered to the site is the most reliable measure of this parameter
   c. Unit/Frequency of Calculation
      i. Weights are recorded by the Well Operator, delivered to Charm, and entered into the Ledger for each injection batch

d. Modifications to Address Uncertainty
    i. Uncertainty considerations have been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details can be found in the Uncertainty Assessment section here and in the GHG Statement supplemental doc

39. Mass of Bio-Oil Injected
    a. Calculation Methodology
        i. Mass of Bio-Oil Injected is computed by subtracting the mass of salt and LCS added to a given batch of bio-oil during pre-processing from the Final Injectate Mass of that batch
    b. Justification of Variables and Emissions Factors Used
        i. The directly-measured mass of the injectate delivered to the site is the most reliable measure of this parameter
        ii. The consumables subtracted from this quantity are also measured directly by site personnel
    c. Unit/Frequency of Calculation
        i. Mass of Bio-Oil Injected is computed for each injection batch
    d. Modifications to Address Uncertainty
        i. Uncertainty considerations have been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details can be found in the Uncertainty Assessment section here and in the GHG Statement supplemental doc
40. Electricity Use from Injection
    a. Calculation Methodology
        i. Well Operator is required to report energy usage monthly per Service Agreement with Charm based on the number of hours spent emplacing Charm material and the overall usage by the site during the same period
        ii. Electricity emissions are calculated by kWh usage multiplied by the per kWh emissions for the SPP North grid subregion as reported by the EPA eGrid emissions factors. This is supplemented by a per-kWh addition to account for the embodied emissions associated with grid infrastructure as quantified by a weighted average of power generation sources based on the fuel mix for the subregion reported by the EPA and the applicable electricity infrastructure emissions factors reported by GREET
    b. Justification of Variables and Emissions Factors Used
        i. Electricity use is measured using a calibrated instrument from the local utility provider calibrated and purpose-built for measuring power usage over time. Given that the readings are the basis for billing for power usage, the utility has a direct incentive to ensure their accuracy
        ii. Subregional grid emissions factors and generation technology mix are provided by the US EPA and grid infrastructure emissions factors from GREET, which are reputable sources under the Isometric Protocol's definition
    c. Unit/Frequency of Calculation
        i. Electricity use is treated as a "site emission"
            1. Metered use rates are reported monthly by site staff
            2. Reported use-rates are multiplied by listed emissions factors to calculate emissions impact of usage
            3. Calculated impact is deducted from net CDR for oil processed

on site

d. Modifications to Address Uncertainty
    i. This value is being used as is due to demonstrating a less than 1% change in the Net Removal in the Sensitivity Analysis. See the "Sensitivity Analysis" sheet in the supplemental GHG Statement doc

41. Embodied Emissions from Injection Equipment
    a. Calculation Methodology
        i. Vaulted calculated the embodied site emissions in their own PDD in terms of the tonnage of steel and concrete per metric tonne of material emplaced in their cavern in light of a conservative assumption of the caverns' overall capacity.
        ii. This allows Charm to calculate embodied emissions per ton of oil emplaced by multiplying those values by the GREET 2023 emissions factors for steel and concrete in order to calculate total embodied CO2e assignable to each injected metric tonne. See "Vaulted Emissions Calc Sheet" in GHG Statement supplemental document
    b. Justification of Variables and Emissions Factors Used
        i. Embodied emission calculations provided by Vaulted have already been validated by Isometric and a selected third-party verifier, therefore should be considered a reliable metric for calculating embodied emissions for operations occurring at Vaulted
        ii. GREET 2023 is a reputable source for emissions factors according to the definition provided in the Isometric Protocol and is the most recent version of the framework
    c. Unit/Frequency of Calculation
        i. This will be applied as a static value to each MT of bio oil injected
    d. Modifications to Address Uncertainty
        i. This value is being used as is due to demonstrating a less than 1% change in the Net Removal in the Sensitivity Analysis. See the "Sensitivity Analysis" sheet in the supplemental GHG Statement doc

42. Carbon Content of Injected Bio Oil
    a. Calculation Methodology
        i. The injectate C content is computed by multiplying the Mass of Bio Oil Injected by the average C content of the samples as established by lab testing. This is then multiplied by 44/12 to convert the C content to the equivalent in CO2e
    b. Justification of Variables and Emissions Factors Used
        i. ISO-certified analytical labs provide a high degree of certainty in analytical measurements
        ii. Results are modified for uncertainty based on the reported relative standard deviation reported by the manufacturer of comparable analytical equipment
    c. Unit/Frequency of Calculation
        i. Tested Carbon content is applied to each Injection Batch in order to complete removal accounting
    d. Modifications to Address Uncertainty
        i. Uncertainty considerations have been applied to this value due to showing a greater than 1% effect on net removal quantity in the Sensitivity Analysis. Details can be found in the Uncertainty

Assessment section here and in the GHG Statement supplemental doc

43. Emissions from Sample Transport to Lab
    a. Calculation Methodology
        i. Emissions are calculated for air shipment of samples based on a conservative estimate of the point-to-point distance between the sampling site and labs in Google Maps, and the weight and number of samples according to the standard testing battery for each injection batch of bio oil established by the Charm Research and Chemistry teams who manage the testing program
        ii. Weight and distance are used to calculate emissions using the GLEC emissions factor for air freight
        iii. See "Emissions from Samples Calcs" in GHG Statement supplemental document
    b. Justification of Variables and Emissions Factors Used
        i. The number of tests, samples, and sample weights are internally standardized for each injection batch and calculated as reported by the Charm Chemistry and Research teams
        ii. Distance between the sampling site and labs is determined according to Google Maps routing. Road distances are used despite the transport assumption being air freight. This is due to the fact that road distances will reliably be longer than the more direct route allowed by air travel, ensuring a conservative estimate of removals
        iii. GLEC qualifies as a "reputable source" for emissions factors given the Isometric Protocol's definition
    c. Unit/Frequency of Calculation
        i. Emissions are applied as a static value to each injection batch
    d. Modifications to Address Uncertainty
        i. This value is being used as is due to demonstrating a less than 1% change in the Net Removal in the Sensitivity Analysis. See the "Sensitivity Analysis" sheet in the supplemental GHG Statement doc

Additional Summary: Lot Emissions vs. Site Emissions

Overview: Emissions associated with bio-oil sequestration are calculated one of two ways.

1. *Lot Emissions* are emissions that can be clearly associated with a particular lot of bio oil. These emissions are associated with a specific lot of oil in the ledger and deducted from the net CDR associated with that specific lot or injection batch of bio-oil.
2. *Site Emissions* are emissions that cannot be associated with a specific lot of oil, but are associated with a particular processing site. These emissions are accrued to the site and deducted from removals associated with the site each reporting period. Site Emissions include, but are not limited to, Embodied Emissions that will be amortized using a time-based straight-line depreciation method based on the expected useful life of equipment.

For clarity and transparency, all emission calculations discussed in this PDD are sorted into Lot Emission and Site Emission categories below

1. Lot Emissions
    a. Pyrolysis Process Emissions
        i. Fuel Use from Feedstock Transport

    ii. Fuel Use from Biomass Pyrolysis
    iii. Electricity Use from Biomass Pyrolysis
  b. Pyrolysis Embodied Emissions
    i. Embodied Emissions from Feedstock Transport
    ii. Embodied Emissions from Equipment and Facilities for Biomass Pyrolysis
  c. Fuel Use from Injectate Transport to Pre-Processing
  d. Vehicle Embodied Emissions from Injectate Transport to Pre-Processing
  e. Embodied Emissions from Liquid Caustic Soda for Injectate Pre-Processing
  f. Fuel Use from Processed Injectate Transport to Injection Site
  g. Vehicle Embodied Emissions from Processed Injectate Transport to Injection Site
  h. Embodied Emissions from Injection Equipment
  i. Carbon Content of Injected Biomass (contra-emission)
  j. Emissions from Sample Transport to lab
2. Site Emissions
  a. Electricity Use from Injectate Pre-Processing
  b. Fuel Use from Injectate Pre-Processing
  c. Fuel Use from Consumables Delivery Transport
  d. Embodied Emissions from Consumables Delivery Transport
  e. Electricity Use from Injection
  f. Fuel Use from Injection

GHG Statement Results

The following information should be provided in this section:

- *Baseline results reported in t CO_2e for the Reporting Period*
- *Net CO_2e removals results reported in t CO_2e for the Reporting Period. These must be aggregated and also broken down into GHG SSRs*
- *If it has not already been covered in the* 'Uncertainty assessment' section of the PDD, provide *outcomes of sensitivity and uncertainty analyses including a statement of how uncertainty affects the results and how it has been addressed to minimize misrepresentation*
- *A statement of how the assumptions and choices made in the assessment are conservative*

The GHG Statement calculations must be provided separately, including all raw data and evidence. The GHG Statement calculations must be clearly referenced with a transparent audit trail of evidence, decision making, assumptions, explanations.

This GHG Statement is being prepared prior to injecting at an operating cadence. A Sample Calculation, representing the first injection associated with the information presented in this PDD is provided in the "Sample Calculation – Trucking from AECN" sheet in the GHG Statement supplemental document.

All calculations will actually be executed in the Ledger and that data will be shared with

Isometric via API. The Sample Calculation is done to show how the associated ledger workflows will function in spreadsheet form.

Because the Sample Calculation is an isolated "example removal" there are some variances in how certain inputs are calculated. In the interest of clarity and transparency, those variances are listed below:

1. Pre-Processing Site Fuel Emissions
    1. What is provided is an estimate of the expected fuel use associated with the volume of oil shown in the sample
    2. In production, fuel will be treated as a "site emission"
        1. Invoiced use rates are reported monthly by site staff
        2. Reported use-rates are multiplied by listed emissions factors to calculate emissions impact of usage
        3. Calculated impact is deducted from net CDR for oil processed on site
    3. Because the site is not yet fully operational, there is not a representative value for the purposes of the Sample Calculation. The estimate is provided to demonstrate the general calculation methodology and estimated impact of fuel pre-processing site fuel usage on total net emissions. This will be replaced with actual usage values in the future, when the site is fully operational.
2. Pre-Processing Equipment Embodied Emissions
    1. This value is based on a value per metric tonne based on dividing the overall embodied emissions by an estimate of the useful lifetime of the equipment in terms of quantity processed
    2. In production, embodied emissions will be amortized over time, rather than production volumes and will be deducted from the net CDR in a reporting period based on time elapsed
    3. Because the Sample Calculation is isolated in time/not associated with a reporting period, the expected quantity processed is used as a proxy. This allows for a demonstration of calculation methodology and an estimation of the impact of equipment embodied emissions on total net emissions absent a full reporting period's injection data. This will be replaced with a time-based amortization in the future, when this site is in full production.
3. Pre-Processing Consumables Embodied Emissions
    1. What is provided is an estimate of liquid caustic soda (LCS) usage based on the average proportion of LCS added to each MT of bio oil in R+D testing
        1. Salt usage is also estimated based on KDHE salinity requirements per volume of bio-oil, but the embodied emissions of the salt itself are not included because it is a waste product
    2. In production, LCS will be measured as it is added to the bio oil and the actual quantity will be used to calculate the embodied emissions
    3. Because the Sample Calculation does not represent an actual batch being processed in normal production conditions, the average proportion is being used as a proxy. This allows for a demonstration of calculation methodology and an estimation of the impact of LCS embodied emissions on total net emissions absent actual weights or volumes used. This will be replaced with actual weights or volumes of addition when the site is fully operational
4. Pre-Processing Consumables Delivery Emissions
    1. What is provided is an estimate of delivery emissions associated with

consumables usage based on the estimated consumables usage described above. The associated fuel usage and embodied emissions are included as part of the overall calculation of consumables embodied emissions.

    2. In production, delivery embodied emissions will be calculated separately. Each delivery will be recorded by site staff, including the origin of the delivery and the weight of cargo delivered to the site. This data will be used to calculate the embodied emissions associated with each delivery; these emissions will accrue as a site emission and deducted from removals associated with the site in each reporting period.
    3. Because the Sample Calculation is isolated in time/not associated with a reporting period, the expected delivery-related transport emissions are used as a proxy. This allows for a demonstration of calculation methodology and an estimation of the impact of consumables delivery emissions on total net emissions absent delivery-specific data. This will be replaced with actual delivery-specific data when the site is fully operational.

5. Electricity Use from Injection
    1. What is provided is an estimate based on calculating the average amount of electricity used per MT emplaced at Vaulted using data from their PDD
    2. In production, Charm will receive monthly energy use reports from Vaulted and that energy use will be calculated as a "site emission"
        1. Reported use rates are reported monthly by site staff
        2. Reported use-rates are multiplied by listed emissions factors to calculate emissions impact of usage
        3. Calculated impact is deducted from net CDR for oil processed on site
    3. Because the Sample Calculation does not represent an actual injection batch, the average amount of electricity used for other other operations is being used as a proxy. This allows for an estimation of the impact of injection electricity use on total net emissions absent an actual report from the well operator